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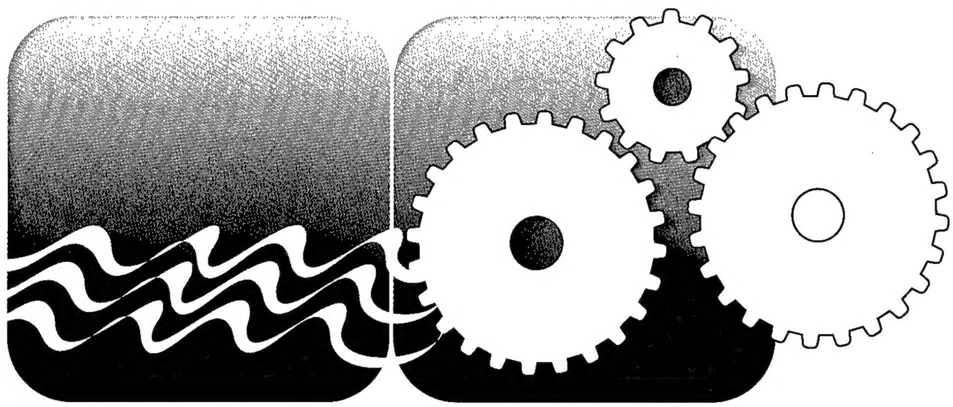
Analyzing Employment Effects of Stream Restoration Investments

Final Report



IWR Report 94-FIS-18
November 1994

Federal Infrastructure Strategy Reports

This is one in a series of reports prepared during the Federal Infrastructure Strategy (FIS) Initiative, an intergovernmental program exploring the development of an integrated or multi-agency Federal infrastructure strategy. The series of reports which chronicle the strategy's development reflect the desire to publish interim documentation as results become available. These documents have been used to facilitate the dialogue within the Federal and non-Federal infrastructure communities as policy deliberations continue. See page 85 for a listing of other FIS reports.

This study reports on a cooperative effort with the U.S. Environmental Protection Agency on the potential employment effects of non-structural stream restoration projects. Using a regional input-output model known as IMPLAN, descriptions of stream restoration practices, and local and national information on expenditures for stream restoration, this study estimates the regional employment creation effects associated with three restoration projects: Anacostia Creek in Maryland and Washington, DC; Boulder Creek in Boulder, Colorado; and Glen Creek in Denali National Park and Preserve in Alaska.

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The Federal Infrastructure Strategy Program

ANALYZING EMPLOYMENT EFFECTS OF STREAM RESTORATION INVESTMENTS

Prepared for:

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Office of Policy, Planning, and Evaluation
United States Environmental Protection Agency
&
Institute for Water Resources
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November 1994 IWR REPORT 94-FIS-18

PREFACE

The quality of the Nation's natural resources has long been a concern for policy makers at all levels of government. However, the nature of this challenge and the responses chosen to meet these needs have shifted with time. Thirty years ago, key water resources problems were addressed through largely capital intensive approaches. Such infrastructure investments are typically projects requiring large amounts of equipment and personnel to construct, resulting in significant edifices that are often in conflict with environmental goals.

The philosophy of response to many of today's remaining water quality and other environmental problems has now shifted. In addition, public concerns about the environment have broadened the government's focus to more explicitly include goals such as restoration and preservation of wetlands and other aquatic habitats. As a result, non-structural and low-capital methods of environmental protection are receiving increased attention, and many infrastructure projects have incorporated explicit environmental goals into their designs. Still others are designed exclusively for environmental purposes.

The construction of projects with significant environmental components is quite different from building other public works in that they often require a different mix of capital equipment and labor. In addition, the impact on the economy is less clear for projects which are aimed at non-monetary outputs. Because of these differences, the direct and indirect employment effects of environmental infrastructure investments have often been difficult to assess and quantify.

The purpose of this study on the employment effects of federal stream restoration investments is to evaluate the direct and indirect employment effects of infrastructure projects with significant, or primary environmental restoration components. The employment impacts studied include effects in the short-run (during implementation activities), direct versus indirect employment, quality and type of employment (labor categories, including skilled versus unskilled workers), and linked employment effects across the economy.

This study is the product of related work of mutual interest between the U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation (OPPE), and the U.S. Army Corps of Engineers, Institute for Water Resources (IWR). While the OPPE was conducting ongoing work on the stream restoration activities among federal agencies, IWR was pursuing related work regarding the economic impacts of various kinds of federal infrastructure investments. Interagency coordination of these efforts resulted in the study documented herein on *Analyzing Employment Effects of Stream Restoration Investments*.

The study was conducted as an element of the Federal Infrastructure Strategy program. It was jointly financed by EPA and the Corps, with the former providing most of the funding. The work was cooperatively managed by OPPE and IWR, and was accomplished by Apogee Research, Inc., through Task Order No. 27, Contract DACW72-90-D-0001 with the Institute.

The study was approached primarily through three case studies which are documented in Chapter IV of this report. The report also includes background information regarding the type of regional economic models available to analysts (Chapters I and II, and Appendix A), and a U.S. Environmental Protection Agency compilation of federal stream restoration programs (Chapter III and Appendix B). Finally, the report also includes a glossary of stream restoration activities used in regional economic analysis models (Appendix C), and an annotated bibliography (Appendix D).

ACKNOWLEDGMENTS

This report presents the results of an analysis of the employment impacts of nonstructural and low-capital investments in stream restoration. This effort was undertaken as one element of a broad interagency initiative, facilitated by the U.S. Army Corps of Engineers and known as the Federal Infrastructure Strategy (FIS).

This particular study was a joint effort between the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers. The concept for the study and most of the funding was provided by the Water Programs Branch of the Office of Policy, Planning and Evaluation at EPA. Administrative, editorial, and study design support and input were provided by staff at the U.S. Army Corps of Engineers Institute for Water Resources (IWR). Modeling work and drafting of the initial report were done by staff at Apogee Research, Inc.

On behalf of the U.S. Army Corps of Engineers, IWR would like to sincerely thank EPA for the opportunity to jointly pursue this work of mutual interest. EPA staff who led the project include Mr. William Painter, Chief, Water Programs Branch, and Ms. Christine Ruf and Mr. Jamal Kadri, also of the Water Programs Branch. Corps of Engineers staff who were involved include Dr. Cameron Gordon and Mr. Robert Pietrowsky of the FIS study team. Apogee staff on the project included Ms. Amy Doll, Mr. Matthew Clark, and Mr. Robert Dietz.

Policy guidance for the overall FIS program was provided by the Office of the Assistant Secretary of the Army (Civil Works), while program execution was overseen by the Corps of Engineers Directorate of Civil Works through Mr. Donald Kisicki, Chief, Office of Interagency and International Activities.

The Corps IWR had detailed management responsibilities for the FIS program under the direction of Dr. Eugene Stakhiv, Chief, Policy and Special Studies Division, and Mr. Robert Pietrowsky, FIS program manager. Mr. Kyle Schilling is Director of the Institute.

TABLE OF CONTENTS

LIST OF EXHIBITS

EXECUTIVE SUMMARY

This study reports on economic development and employment effects of non-structural stream (riparian) restoration. Using a regional input-output model known as IMPLAN, detailed descriptions of stream restoration practices, and local and national information on stream restoration expenditures, this study estimates the regional economic development and employment creation effects associated with three restoration projects: Anacostia Creek in Maryland, a highly degraded urban stream and the site of the largest restoration project in the country; the Boulder Creek restoration project in Boulder, Colorado, being tested as an alternative to expensive structural water quality improvements; and Glen Creek in Denali National Park, Alaska, an attempt to restore fragile northern habitats damaged by placer gold mining.

COMPARISON OF RESTORATION AND STRUCTURAL MEASURES

Stream restoration often proves to be effective at job creation, primarily because restoration activities are relatively labor intensive. Additionally, compared to similar scale construction projects, a larger portion of a stream restoration project's capital inputs are often drawn from local sources. As a result, restoration projects may create more spin-off employment for local suppliers during implementation than do structural solutions of the same order of magnitude or within a low capital context. Finally, and most significantly, restoration may sometimes be more cost-effective[1] than structural approaches at achieving selected water quality goals. Both structural and non-structural water quality measures are commonly financed by local, state or federal government revenues from taxes or rates paid by individuals and businesses. Therefore, it can also be argued that, because the private sector is believed by many to be more efficient at creating employment than the public sector, government expenditures within this context would tend to lower the overall potential for job creation and economic growth by moving funds from private activities into public activities.

Nationwide, direct federal investments in stream restoration reached approximately $72 million (in non-inflated 1991 dollars) in federal fiscal year 1993. These expenditures were estimated to generate over 3,000 job-years of employment, and create spin-off spending of about $400 million to the U.S. economy (see Exhibit ES-1).

This report focuses on case studies of the Anacostia River, Maryland; Boulder Creek, Colorado; and Glen Creek in Denali Park and Preserve, Alaska as illustrative of the types of employment impacts that nonstructural measures can have. The demographic characteristics of these areas are as diverse as their locations, with the exception that each is characterized by high unemployment among some segments of the population. One other common characteristic of the three projects is that each received financing through one or more federal programs.

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[1] Cost-effectiveness indicates a less costly alternative means to achieve a policy objective.

Exhibit ES-1 - Employment and Economic Effects of Case Studies (1991$)

	Expenditure ($000)	*Regional Effects ($000)*	*Restor. Direct Job-yrs Created*	*Restor. Indirect Job-yrs Created*	*Restor. Induced Job-yrs Created*	*Total Restoration Job-yrs (A)*
Anacostia River	12,735	43,000	208	48	198	454
Boulder Creek	742	21,000	13	3	11	27
Glen Creek	413	690	6	2	3	11
Federal Programs	72,000	405,000	960	390	1,740	3,090

Each of these projects were evaluated to identify how many and what types of jobs have been created from restoration activities, as well as the extent to which the employment creation benefitted the regional economy.

As shown in Table ES-1, the **Anacostia River** study area represented the largest stream restoration expenditures (projected to be $12,735,000 over the life of the activity). The Anacostia project involves urban storm water management, wetland restoration, stream and fish habitat restoration. Based on the IMPLAN analysis documented herein, project expenditures are expected to generate 454 jobs in the State of Maryland, including 208 jobs directly associated with the restoration activities along the stream. Another 48 jobs are estimated to result in Maryland as supplies of tools, equipment, and materials such as nursery products, construction equipment, rebar, fencing, logs, sand, and gravel. An additional 198 jobs are expected as a result of respending of direct and indirect wages within the service industry sectors such as housing, food services, and banking. Using a composite total output multiplier of 3.4 for the State of Maryland, the direct investment of $12.7 million on the Anacostia River would generate at total value of approximately $43 million of increased economic activity. Although this multiplier is somewhat high compared to investments in many industries, it is considered appropriate based on the labor intensive nature of the restoration activities, with the personal consumption expenditures from increased wage earnings generating relatively high levels of in-state economic activity.

The scales of the **Boulder Creek** nonpoint (water quality) demonstration and the **Glen Creek** mining restoration components are significantly smaller than the Anacostia project, costing $742,000 and $413,000, respectively. These restorations are estimated to create a total of 38 jobs. Unique aspects of the Boulder Creek results include its reasonably close fit between the project activities and the Colorado IMPLAN model, and the anecdotal evidence that these results may somewhat underestimate the indirect employment impacts. In addition, existing unemployment rates in the Boulder area suggest that the jobs created by the restoration project may be "net" jobs, rather than displacement from other industries or activities, and may address employment needs for some chronically underemployed segments of the population.

The **Glen Creek** Restoration Project created about 11 jobs in the Alaskan economy over a six-year period (about two jobs per year). Over ninety percent of the jobs were created by revegetation, bank and floodplain stabilization and other site work, and the industries that provide supplies to these activities, such as nurseries, heavy equipment suppliers, and trucking companies. Although few people live in the remote area of the project, the unemployment level is high, averaging 11 percent for the Borough of Denali, Alaska. Therefore, the Glen Creek Project, although small, had a measurable impact of lowering the borough's unemployment rate by about four percent.

Nationwide, 1993 direct federal investments in stream restoration were estimated to be approximately $72 million (1991 dollars). The most significant programs are within the U.S. Forest Service, U.S. Fish and Wildlife Service, and the Bureau of Land Management, which, combined, total over $46 million. The U.S. Army Corps of Engineers expended approximately $7.8 million on wetland and stream restoration in 1993.

Not considering the offsetting impacts of taxes on private sector productivity, these total federal expenditures created over $400 million of increased economic activity and 3,100 jobs in the U.S., based on a weighted total output multiplier of 5.63.

LONG RUN BENEFITS OF RESTORATION

An important consideration for long-term economic growth is the restoration industry's domination by small firms - the kind responsible for creating a significant portion of new jobs in the U.S. (variously estimated at 40 percent to 80 percent of new jobs). Restoration is a new, high-growth and entrepreneurial industry that is creating specialized suppliers and innovative technologies. Its growth potential is even larger where restoration provides a cost-effective substitute for structural measures. Restoration has, in a number of circumstances, provided both short- and long-term employment, as well as career opportunities to the chronically unskilled and underemployed - homeless, young adults, and those with limited English skills. Teaching these individuals restoration and building skills that will be in demand for some time could reduce unemployment in those demographic sectors over a longer term.

In the case studies considered here, and in many more that were researched for this study, the desire of the public to restore pleasant natural stream conditions has created a "bow wave" of entrepreneurial activity. That is, these publicly-initiated projects stimulated the development of new stream restoration techniques. Private organizations and area governments that learned of these projects and their new approaches, applied the methods to local streams, creating additional work for stream restoration firms.

CHAPTER I. REGIONAL ECONOMIC AND EMPLOYMENT ANALYSIS

Regional employment analyses consider how projects add value to an economy, create direct jobs and affect regional economies (create indirect and induced jobs). Analytical approaches vary from simple descriptive case studies to analyses using large, data-intensive models, which trace the effects of a project through the regional economy. This stream restoration study uses both case studies and a computational model. This chapter describes the analytical frameworks (models) available for regional analysis, the adjustments needed in these approaches to make them suitable for analyzing nonstructural or low capital investments, and the approach used here.

Many employment analyses have been conducted for government capital investments such as roads and sewage treatment plants. However, there are very few analyses of non-structural or low capital (NS/LC) expenditures. The techniques used to consider the effects of capital intensive investments are valid tools for analyzing NS/LC investments, provided that expenditures are described in detail and adjustments are made to compensate for fundamental differences between capital and non-capital investments. Models commonly used to analyze capital projects often focus on attributes that are not applicable for non-capital investments. The following chapters describe the detailed stream activity model used to analyze employment effects, and its application to three case studies.

GENERAL APPROACH

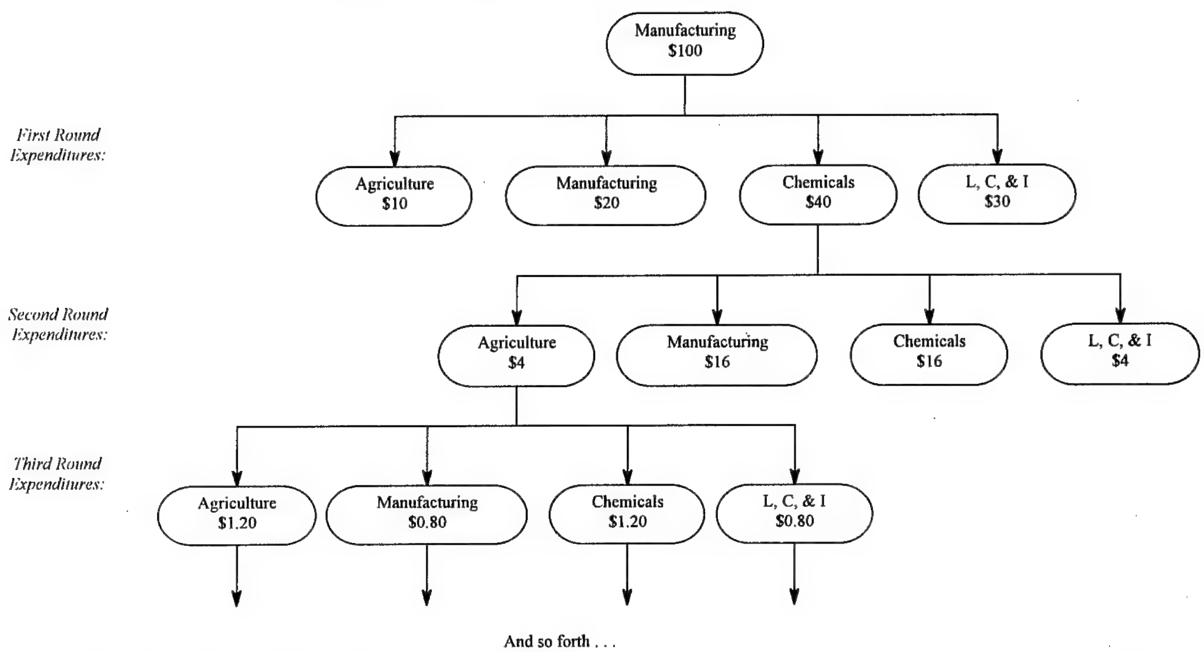
Regional economic analysis attempts to predict a program or project's employment and economic impacts, based on their direct and indirect expenditures, labor requirements and regional industrial composition. The two principal analytical steps are: the identification of changes in expenditure patterns in each industry affected by a new policy or program (e.g., increased or reduced supply or demand; increased or reduced production costs), the tracing of the effects of those changes on related industries (vendors and customers) and the regional economy. For the latter step, regional analyses frequently use models that have already identified the patterns of transactions among industries in the regional economy.

The basis of most regional analyses is a table that describes historic patterns of expenditures among industries. Exhibit 1 is a simplified representation of such a table for a hypothetical economy with only three components: agriculture, manufacturing and chemicals. All inputs for each of the three economic sectors in the top row must come from the sectors shown in the left hand column, so that total inputs reading down must sum to 100 percent in the bottom row.

Exhibit 1.a - A Simple Matrix for Regional Economic/Employment Analysis

Inputs	Outputs: Agriculture	Outputs: Manufacturing	Outputs: Chemicals
Agriculture	.3	.1	.1
Manufacturing	.2	.2	.4
Chemicals	.3	.4	.4
Labor, Capital, Inventory	.2	.3	.1
Total	***1.0***	***1.0***	***1.0***

Exhibit 1.b - Simulated Expenditure Cycle



In Exhibits 1.a and 1.b, if $100 were initially invested in manufacturing (shown in column 2, under outputs), $10 would be spent in the agricultural sector (e.g., cotton fiber), $20 would be spent in the manufacturing sector (e.g. weaving machines for a textile factory), $40 would be spent in the chemical sector (e.g., fuel and feedstocks), and $30 would be spent on labor, existing (depreciating) capital and other inputs (also known as "value added"). These expenditures generate a second round of expenditures, where, for example, of the $40 spent on chemicals, 10 percent, or $4, would be spent on agriculture, 40 percent or $16 dollars, on manufacturing, another 40 percent on other chemicals, and 10 percent on labor and other inputs. Regional analyses continue to trace these cycles until the dollar amounts are negligible and consider the labor to capital ratio and prevailing wages to calculate the increased employment and output in the regional economy.

COMPONENTS OF REGIONAL ANALYSIS

Economies are too complex to analyze without the aid of computerized computational models. In order to accurately estimate employment results from regional models, information is needed on the following: the type of expenditure - direct, indirect or induced; the degree of aggregation of industries or industrial sectors; regional shares of production of specific commodities; and the interactions among these components. The selection of a modeling approach for this analysis was based principally on the way the available regional modeling packages treat these factors. The following sections discuss the components needed to accurately estimate employment effects:

Types of Costs: Direct, Indirect and Induced

Stream restoration, like all public investments, has direct, indirect and induced employment and economic effects during the implementation period that are identified in computerized regional economic models. These effects are defined below:

<u>Direct effects:</u> Direct employment and output is created as a result of investment in the activity of primary interest. Direct effects of non-structural investment include expenditures for laborers working in the stream corridor, equipment and operators used for excavation, public agency employees involved in supervision, and engineers and ecologists involved in project planning, design, and evaluation.

<u>Indirect effects</u>: Indirect employment and output is created by suppliers of goods and services to direct activities. Stream restoration indirect jobs would include jobs created at nurseries that supply plant stock, quarries that provide stone and gravel, heavy equipment and tool manufacturers and retailers, and suppliers of office equipment for agency staff and consultants;

<u>Induced effects</u>: Induced employment and output is created by the respending of wages of those employed directly and indirectly (e.g. the spending of workers' wages at the grocery store). Induced effects can provide a considerable boost to local economies because they tend to affect labor-intensive service industries, e.g., retail, real estate, groceries and restaurants.

Output Multipliers

As expenditures move through the local economy, as in Exhibit 1, they generate other expenditures and value added, and increase the total output (in dollars) of the local economy by more than the original amount invested. For example, a stream restoration contractor may purchase a television with his earnings. The price of the good pays for part of the t.v. salesman's wages as well as payment to an electronics' wholesaler. The degree to which the total regional economic output is increased is measured by a total output multiplier, which is a function of the ratio of indirect and induced output to direct expenditures, or

$$(indirect + induced)/direct = total\ output\ multiplier$$

Total output multipliers are specific to each industry, and provide a measure of the benefit of expenditures in each industry to the whole regional economy.

Bills of Goods and Aggregation

The basic building blocks in regional analysis are "bills of goods" or final demands. These are detailed descriptions of the direct expenditures required to accomplish a project or activity of interest. Final demands can be conceived of as a column of all expenditures made on the project being studied, which sums to the total project cost. Regional economic models use more complex versions of the matrix in Exhibit 1 to trace the effects of final demand expenditures throughout an economy. Exhibit 2 shows a final demand vector for one restoration activity or Best Management Practice (BMP). In this example, construction and landscaping costs comprise 11.08 percent of total direct project expenditures while gravel and rock add 38.48 percent. Total labor accounts for 31.74 percent of total direct project expenditures in Exhibit 2, total capital 57.54 percent, and overhead 10.72 percent.

Exhibit 2. Restoration Activity Final Demand: Boulder Placement

Commodities	Percent of Final Demand
Construction/Landscape	11.08%
Equipment Operator	14.31%
Supervisor/Planner	6.35%
Total Labor	*31.74%*
Gravel, Rock	38.48%
Construction Vehicles	17.32%
Hand Tools	1.75%
Total Capital	*57.54%*
Overhead	10.72%
TOTAL	***100.00%***

Final demands can be very detailed, or disaggregated, or they can be very aggregated (i.e., include many industries in one category). Exhibit 3 shows a more detailed description of costs provided by disaggregated final demands. The more detailed the information on expenditures is, the more accurate the regional results will be. Accurate identification of regionally produced products or services is important, because only locally-made products or wage receipts can generate indirect and induced employment effects. Each commodity has a regional purchase coefficient (RPC), with values ranging between 0.0 and 1.0, which indicates the proportion of the commodity demanded in the region that is produced within the region. Projects that use commodities with higher RPCs will generate more regional employment. Commodities with low RPCs have a lot of "leakage", that is, revenue lost to the local economy - for example, in a Michigan regional model, an automobile built and used in Detroit has a higher RPC than a Japanese-built bulldozer.

Aggregation blends all manufacturing together, and causes the identification of local content to be lost. This may misstate regional economic and employment effects - for example, in Exhibit 1 above, an expenditure on locally-made tools would be counted as "manufacturing", as would expenditures on foreign-made cars. Such a result would underestimate local employment of a restoration project that uses tools and not cars.

The confounding effects of aggregation can be exaggerated with non-structural investments, which are often categorized with related industries, such as traditional construction, which have a higher

Exhibit 3. A Stream Restoration Project: Aggregated & Disaggregated Inputs

Aggregated			Disaggregated		
Input (final demand)	Cost	% of Total	Input (final demand)	Cost	% of Total
Tools and Machines	$30,000	20%	Planning and Design	$5,000	3%
Materials	$40,000	27%	Heavy Equip. Rental	$10,000	7%
Labor	$80,000	53%	Equipment Operation	$18,000	12%
Total	***$150,000***	***100%***	Hand Tools	$10,000	7%
			Seed	$100	0%
			Trees	$400	0%
			Rocks	$18,000	12%
			Logs	$8,000	5%
			Fencing	$500	0%
			Installation Labor	$50,000	33%
			Supervisory Labor	$30,000	20%
			Total	***$150,000***	***100%***

proportion of capital to labor inputs and are likely to use more imported products than non-structural investments. Expenditures on stream restoration activities tend to use materials (e.g., logs, boulders) that can be found locally, and that are too low in value to be transported long distances. An important criterion in selecting a computational model for this study was its ability to accurately identify and trace the effects of restoration expenditures[2].

Efficiency and Distributional Effects

As noted above, the most cost-effective, or efficient government investment that achieves a legitimate public purpose will create the most economic benefits for society. These will be translated into employment through the investment and respending scenario described above. Nonetheless, employment creation may not be an unconditional benefit to a local economy. The benefits of government expenditures in a region depend upon the regional availability of labor and the skills required for the jobs created. Where there is full employment, a government investment may simply increase demand for labor, causing workers to shift from one job to another. Where skills are required that are not available locally, labor will migrate into the region to fill temporary jobs, which, if the project is large enough, may cause undesirable "boom and bust" effects. Large capital projects may require substantial infrastructure investment and cause population growth and crowding of services for several years, and then end abruptly, leaving local economies and services over-taxed and over-capitalized for the remaining population. Non-structural projects, which tend to be smaller and initially demand lower-skilled workers, can benefit a regional economy that has less than full employment in low-skilled labor markets.

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[2] Location greatly influences the use and costs of local vs. nonlocal inputs. For example, the low freight costs of the Inland Waterways System may justify the use of nonlocal materials.

Types of Regional Economic Models

There are three basic regional economic models available to analyze the employment effects of non-structural and low capital environmental investments: (1) input-output (I-O); (2) econometric/simulation/general equilibrium; and (3) export-based. Several of these are available in personal computer-compatible formats. A more detailed description of each regional analysis model is contained in Appendix A. An input-output model, which is the most widely-used approach to regional analysis, was chosen for this study. Its advantages over econometric/simulation and export-based models are availability of more current and highly disaggregated industry data, ability to identify RPCs and significantly lower cost.

The selected I-O model, IMPLAN, was chosen based on the applicability of its features to the subject study, including:

- greater disaggregated final demand analysis (532 industrial sectors);
- reasonably accurate estimates of RPCs;
- more relevant and recently updated data;
- immediate availability; and
- cost-effectiveness.

A limitation of input-output models is their failure to adjust for full employment conditions, i.e., they classify all job creation effects as beneficial, rather than acknowledging inflationary pressures on wages and prices as would an econometric model. However, data are more disaggregated. In this study, the employment characteristics of each of the case study regions are considered separately to determine how beneficial the employment creation effects are.

CHAPTER II. ECONOMIC IMPACTS OF STREAM RESTORATION

Economic impact analysis of non-structural stream restoration investments requires an understanding of the components of a stream restoration project - its labor and capital (materials) requirements - as well as the project's spin-off effects on the local economy. In this analysis, the following procedure was used to estimate these effects:

1. Detailed components of non-structural stream restoration activities were identified, including the relative costs of labor and capital requirements - organized into a comprehensive final demand template (matrix of activities and inputs) (Appendix B);

2. A regional economic model (IMPLAN) was used to determine the economic impacts of these activities in different case study areas; and

3. A restoration activity template and regional model was applied to three case studies of stream restoration projects in the study areas, and for federal government expenditures in the United States economy.

These three major steps are described in greater detail below.

IDENTIFICATION OF STREAM RESTORATION ACTIVITIES

The first analytical step identified a comprehensive list of non-structural stream restoration activities being conducted nationwide. This effort included on-line database and library literature searches of books, journal articles, government publications and conference proceedings. Additionally, information was informally requested from public and private sector stream restoration experts and practitioners from around the country. Information was then compiled into a comprehensive list of restoration activities, which was condensed into 20 final "best management practices" (BMPs) by excluding activities that (1) could be considered "structural," (e.g. fish elevators), (2) were considered by the contacted experts to provide unreliable results (e.g., gabion matting, which can trap fish), or (3) could be considered a "variation" of other activities in the list. There are many variations of the activities listed here; the ones selected represent those commonly used by the contacted restoration practitioners. Not all of the BMPs listed here will be used in every project, and there are a number of regional exceptions. Nonetheless, this list represents a reasonably comprehensive package of restoration practices common to many projects nationwide.

The final list of 20 non-structural stream restoration activities (BMPs) includes:

- planting grass in the riparian zone
- planting shrubs
- constructing a channel block
- installation of a rootwad
- placement of a bank crib and cover log
- installation of a single-wing deflector
- construction of a wedge, K, or other dam
- chain link fencing
- installation of a brush bundle
- construction of a trash catcher dam
- planting trees
- removing debris
- instream boulder placement
- installation of tree cover
- construction of a log and bank shelter
- construction of a channel constrictor
- barbed wire fencing
- addition of a meander to a stream bed
- armoring a streambank with rip-rap
- streambank grading

AN INPUT/COST MODEL FOR STREAM RESTORATION ACTIVITIES

Most stream restoration projects are composed of some combination of these in-stream and-near-stream activities (or variations thereof). Projects also involve planning, organization, supervision and monitoring (shown as "Supervisor/Planner" and "Overhead" in Exhibit 2). Because information regarding these components of stream restoration was largely unavailable, the case studies were used to provide a range of relevant costs and job creation effects.

Labor and capital inputs (commodities) were identified using published references and contacts with restoration experts. National summaries of costs and prices were used to identify the cost of each material input and the average wage rate for each type of labor. Costs[3] that were not available from these sources were identified by direct interviews with regional material suppliers - for example, a local quarry was contacted to obtain the average cost of a boulder.

A percent of total activity cost was allocated to each input (one of the 532 identifiable commodities or industries in IMPLAN) based on actual expenditures, and assigned a Standard Industrial Classification (SIC) code for use in the IMPLAN model. A multiplier - job-years per million dollars invested (jobs-per-million) - was identified for each stream restoration activity by assigning $1 million of expenditures to each activity, allocating these expenditures across all capital and labor inputs, and tracing the effects of the allocated expenditures through the regional economy in IMPLAN. This procedure identified the direct, indirect and induced employment resulting from expenditures of $1 million on each BMP (Total employment was calculated as the sum of the three employment sources). The economic impacts of actual stream restoration activities could then be evaluated by multiplying actual project or program expenditures on each activity by the jobs-per-million multiplier for the activity. Total output in each regional economy

[3] All costs are adjusted to 1991 dollars using the Producer Price Index (PPI). Two per cent of the capital and labor cost is added as the cost for hand tools for each activity, and 12 per cent of that (sub-) total is added as the administrative cost of each activity. The sum of these components provides the total cost of each activity (Note: some activities require additional calculations; for example, to estimate the cost of adding a meander requires estimating the geometrical volume of an excavated stream bed).

(and in the nation as a whole for federal program expenditures) were calculated by multiplying total project or program expenditures by a multiplier (derived in IMPLAN) that reflected a weighted average of all stream restoration activities.

Stream restoration planners can use this model to evaluate the economic development impacts of a proposed restoration project. With estimates of the types and amount of restoration activities required to restore any given stream, the employment effects of a proposed restoration project can be estimated using the approach described here. To facilitate this, each restoration activity was evaluated by the most appropriate unit cost, such as (average) cost per structure or per stream mile. Activities such as installation of instream structures can be evaluated on a average cost per structure basis, whereas costs for activities such as fencing or reforestation can be estimated on a per mile, per acre, or per tree basis. Where project planners know the number of stream miles to be restored or structures needed, they can also determine the regional economic impacts, where the models of local economies are available to them.

APPLICATION OF THE MODEL TO DETERMINE REGIONAL IMPACTS

Models of the economies of Maryland, Alaska, and Colorado, and for the U.S. as a whole, (one for each of the case studies) were developed in IMPLAN. Each state model contains information on the amount and direction of the flow of money through the various industries and institutions of the state, as well as the local content of each of 532 commodities. A measure of the labor intensity of investments is the number of total jobs created per million dollars of investment. The jobs/million figure is region-specific because the local content of the inputs to each activity, which determines the indirect and induced economic effects, is also region-specific. The three categories of jobs (direct, indirect and induced) were each evaluated using the IMPLAN model (Exhibit 4). As Exhibit 4 shows, the area with the largest economy (the U.S.) has the highest indirect and induced employment effects - 31.15 jobs per $1 million spent - because its RPCs are the highest. Because it is the region with the smallest, least self-contained economy (most imports), Alaska has the lowest indirect and induced employment effects within the region. If the focus of concern is national rather than regional employment creation, use of U.S. multipliers, (for example the right-hand column in Exhibit 4), will provide estimates of project-related employment at the national level.

Exhibit 4. Direct, Indirect and Induced Effects (jobs/$ million) for One Restoration Activity

Activity:	Maryland	Colorado	Alaska	U.S.
Direct Effects	7.09	7.09	7.09	7.09
Indirect Effects	4.97	5.53	3.92	6.14
Induced Effects	9.20	9.85	4.57	17.92
Total Effects	***21.26***	***22.47***	***15.58***	***31.15***

Direct labor effects for each BMP were obtained by identifying labor costs (wages) for each activity and calculating the number of jobs by dividing by average wage costs for the labor category used. Estimates of induced employment created by the respending of these wages were derived by evaluating the personal consumption expenditure (PCE) patterns for wage earnings in each region (provided in the

IMPLAN model). Indirect and induced employment were derived by identifying the non-labor components of each of the 20 restoration activities, and using IMPLAN to estimate indirect and induced employment and total output multipliers for each scenario. Overhead was allocated to the federal government, because the scenarios are based on federal and state expenditures[4].

[4] See Chapter I for greater description of direct, indirect and induced employment.

CHAPTER III. FEDERAL GOVERNMENT STREAM RESTORATION PROGRAMS

At least 20 federal programs currently conduct or are authorized to conduct stream restoration activities, including: the Department of Agriculture, Department of Commerce, Department of Defense, Department of the Interior, and the U.S. Environmental Protection Agency (See Exhibit 5). Appendix B provides more detailed descriptions of the federal programs. Direct, indirect and induced employment categories are described in greater detail in Chapter I.

FEDERAL PROGRAMS

Several federal fisheries programs (e.g., *Rise to the Future Fisheries Program, Fish & Wildlife 2000*) include stream restoration activities as part of fish habitat enhancement efforts on federal lands. At least one federal program, the *Bring Back the Natives* initiative, conducts projects that focus on stream restoration to restore degraded habitat in order to reestablish native aquatic species. This latter program is coordinated by the Bureau of Land Management and the U.S. Forest Service, which together manage 70 percent of all federal lands in the U.S. Because these lands include 283,000 miles of streams, these programs have significant potential to address stream restoration needs on public lands.

Some federal programs focus primarily on wetland restoration but conduct riparian restoration where such activities complement specific wetland restoration projects (e.g., *Wetlands Reserve Program, Riparian-Wetlands Initiative, Private Lands Habitat Assistance and Restoration Program*). Other federal programs include stream restoration activities as eligible for program funding, but the funding varies considerably. For example, projects funded under EPA's *Nonpoint Source Implementation* Grants vary among states and may include projects that directly restore riparian areas. Several federal cost-share programs (e.g., *Agricultural Conservation Program, Stewardship Incentive Program*) may fund stream restoration activities on private lands based on demonstrated need.

Federal expenditures on the programs described in Exhibit 5, create jobs across the country. Exhibit 6 shows the type of jobs (direct, indirect and induced) and the programs in which jobs are created. Some programs are primarily stream restoration programs, but most include stream restoration as one of several objectives. Information regarding the proportion of program funding dedicated to stream restoration was used where available. In other cases, program descriptions were consulted to approximate stream restoration expenditures (between 10 percent and 30 percent). Where no information was available and stream restoration was a minor program element, stream restoration costs were assumed to account for 5 percent of program expenditures. Employment figures were based on averages for all stream restoration activities, using the U.S. IMPLAN model.

Exhibit 5. Federal Programs with Stream Restoration Activities

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	AGENCY/ OFFICE
U.S. Department of Agriculture	Agricultural Conservation Program	Agricultural Stabilization and Conservation Service (ASCS)
	Wetlands Reserve Program	ASCS
	Rise to the Future Fisheries Program	U.S. Forest Service (USFS)
	Stewardship Incentive Program	USFS
	Taking Wing Program	USFS
	Rural Abandoned Mine Program	Natural Resources Conservation Service (NRCS)
	Soil and Water Conservation Program	SCS
U.S. Department of Commerce	Coastal Zone Management Program	National Oceanic and Atmospheric Administration (NOAA)
	Coastal Zone Management Program: Coastal Nonpoint Pollution Control Program	NOAA and U.S. Environmental Protection Agency (EPA)
U.S. Department of Defense	Section 1135 Program	U.S. Army Corps of Engineers (USACE)
	Marine Fish Habitat Restoration and Creation Program	USACE and NOAA
U.S. Department of the Interior	Fish & Wildlife 2000	Bureau of Land Management (BLM)
	Bring Back the Natives Initiative	BLM, USFS, and National Fish and Wildlife Foundation
	Riparian-Wetlands Initiative	BLM
	Bay/Estuary Program	U.S. Fish and Wildlife Service (USFWS)
	Private Lands Habitat Assistance and Restoration Program/Partners for Wildlife	USFWS
	Federal Aid in Sport Fish Restoration Program	USFWS
	Federal Aid in Wildlife Restoration Program	USFWS
	Rivers, Trails, and Conservation Assistance Program	National Park Service
U.S. Environmental Protection Agency	Nonpoint Source Program Implementation Grants	Office of Water; Office of Wetlands, Oceans, and Watersheds

Exhibit 6. Estimated Federal Stream Restoration Expenditures and Employment Effects[5]

Agency	Program	Estim Expend*	Direct	Indirect	Induced	Total
USDA-ASCS	ACP -Stream protection	$591,889	8	4	15	27
USDA-ASCS	ACP -Streambank	$280,584	3	2	6	11
USDA-ASCS	WRP	$1,390,710	18	8	34	60
USDA-FS	RTTF	$11,104,400	148	60	268	476
USDA-FS	SIP	$895,000	12	5	22	38
USDA-FS	Taking Wing	$450,000	6	2	11	19
USDA-SCS	RAMP	$662,500	9	4	16	28
NOAA	CZM -Sec. 306	$1,773,600	24	10	43	76
NOAA	CZM - Sec. 309	$211,340	3	1	5	9
DOD-USACE	Sec. 1135	$7,840,000	104	42	189	336
USDI-BLM	F&W 2000	$9,141,250	122	49	221	392
USDI/USDA	BBTN	$1,700,000	23	9	41	73
USDI-BLM	Rip/WL Initiative	$4,694,250	62	25	113	201
USDI-USFWS	Bay/Estuary	$440,000	6	2	11	19
USDI-USFWS	Private Lands/PFW	$2,231,000	30	12	54	96
USDI-USFWS	Sportfish Restor. Prog.	$17,551,910	233	95	423	752
USDI-USFWS	Wildlife Restor. Prog.	$8,251,343	110	45	199	353
USDI-NPS	R,T&CAP	$348,250	5	2	8	15
USEPA	Nonpoint Grants	$2,500,000	33	14	60	107
Total		***$72,058,027***	***958***	***390***	***1,739***	***3,087***

* where applicable, estimates include 25% matching funds

FEDERAL EXPENDITURES

Nationwide, direct federal investments in stream restoration in 1993 were estimated to be over $72 million (1992 dollars). The most significant programs are the Forest Service, Fish and Wildlife Service and Bureau of Land Management programs to restore fish and wildlife habitat on public lands. Combined these programs account for over $46 million in federal expenditures. The U.S. Army Corps of Engineers is also responsible for significant expenditures on wetland and stream and river restoration (approximately $7.8 million).

Not considering the offsetting effects of taxes on private productivity, total federal expenditures created approximately 3,100 jobs in the U.S. (job effects deflated to 1991 dollars). Employment creation rises and falls with funding on an annual basis. In Fiscal Year 1993, federal stream restoration expenditures created over $400 million of increased economic activity in the United States (using a weighted total output multiplier of 5.63).

[5] Figures in Exhibit 6 were obtained from officials active with each agency program.

CHAPTER IV. CASE STUDIES

The three case studies discussed in this chapter evaluate the economic impacts of actual non-structural stream restoration projects. The three restoration projects -- the Anacostia River in Washington D.C. and Maryland, Glen Creek in Denali National Park and Preserve in Alaska, and Boulder Creek in Colorado -- were chosen from among dozens for study because of their diversity in stream type, geographic location, water quality problems, and magnitude of the restoration effort. These projects were evaluated to identify how many and what types of jobs were created, as well as the extent to which the employment creation benefited the regional economy.

The first case study, the Anacostia River watershed in Washington, D.C. and Maryland, comprises a major portion of the nation's capital urban/suburban metropolis. The Anacostia project involves urban storm water management, wetland restoration, land use planning and management, and stream and fish habitat restoration. Stream restoration is a relatively small but important component of the project.

Boulder Creek, Colorado, the second case study, is located in a semi-arid, urbanizing area. This restoration project is relatively well known because it is a unique example of stream restoration substituting for, as well as complementing, capital intensive water quality improvements.

The third case study, the Glen Creek project in Denali National Park and Preserve, Alaska, investigates restoration of mine-damaged streams in a remote and fragile northern ecosystem, where restoration work could only be conducted three months each year.

The demographic characteristics of the three areas are as diverse as their location, with the exception that each is characterized by high unemployment among some segments of the population. One common characteristic of the three projects is that each received financing through one or more federal programs (e.g. EPA, the Army Corps of Engineers, the National Park Service), and each is a laboratory for regional restoration research which has generated considerable technology transfer to other restoration projects in nearby watersheds. The three projects demonstrate the widespread and increasing interest in, and robustness of restoration activities for achieving water quality objectives.

ANACOSTIA RIVER, MARYLAND

Background

The Anacostia River basin, a fan-shaped area of 170 square miles with two main branches (the Northwest and the Northeast) and 16 sub-watersheds, is located in Maryland and Washington, D.C. The Anacostia basin has been undergoing development since European settlers began clearing land for farming and using the river to transport crops in the early 17th century. By the early 1800s, sedimentation from

agriculture and deforestation made the port of Bladensburg unfit for navigation. Subsequent urban and suburban development replaced agriculture as the major land-uses in the watershed, which now has a population of 600,000. Widespread development has aggravated the sediment problem, and added the additional problems of combined sewer overflows, storm water discharges, toxic residues, trash and general degradation. Much of the Anacostia River is in low income urban areas. Based on the quality of the aquatic habitat it provides, the Anacostia River has been named America's fourth most endangered river (American Rivers, 1993).

Evidence suggests that the ecosystems in and around the Anacostia River were healthy until the first part of the twentieth century. Now, however, extensive urbanization and poor soil management practices have acted with natural geological processes to stress plant and animal communities around the river. The Anacostia River and its tributaries flow from the Piedmont Plateau through the Coastal Plain. The Piedmont Plateau is characterized by mostly non-absorbent surface rocks and soils that can cause excessive runoff and flooding in the Coastal Plain. The large quantity of impervious surfaces in the watershed have also contributed to runoff problems. Seventy-seven percent of the sub-basin that contains the tidal portion of the Anacostia has been developed within the District of Columbia (68 percent in Maryland), leaving only 23 percent as undeveloped areas and parks. Many of the sub-basins that contain the tributaries to the river are also highly developed. This development and other human influences in the area have significantly increased the already high runoff and flooding rates, harming natural habitats. The wetlands around the Anacostia, especially on the tidal section of the river, have suffered the most damage. Choked by runoff and dredged and filled for various development projects, the aquatic vegetation and wildlife habitats of this region have almost completely vanished. In addition, other pressures from the highly urbanized surroundings, such as increased temperatures, have further disrupted the natural ecology of the Anacostia.

Problem

The Anacostia's[6] major problems include:

- Poor water quality. The Anacostia's streams have high levels of sediment, nutrients, solids, hydrocarbons, metals, pesticides and fecal material, and many parts of the river are characterized by low levels of dissolved oxygen;

- Decline in the quantity and variety of river wildlife. Most native resident fish species have been eliminated throughout the Anacostia system, and migration of anadromous species is limited to the lower segments of the watershed by blockages. The densities of macroinvertebrates in many areas are far below normal values;

- Loss of vegetation. More than half of the forest cover for the whole watershed has been cleared, with even greater losses of cover along stream banks in the system. Wetlands throughout the system have also been filled or drained, with resulting loss of plants and habitat.

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[6] The area of the Anacostia River from the Potomac River, north to the convergence of branches at Bladensburg.

The Anacostia Restoration Program

The condition of the Anacostia generated substantial concern among individuals and organizations which coalesced into a working effort to restore the river in 1984. Over 100 public and private organizations have participated in the Anacostia restoration effort since it officially began in 1987. Key organizations, which include federal, state and local planning, environmental protection and fish and wildlife agencies, and non-governmental organizations, are described in Exhibit 9 at the end of this section.

The Metropolitan Washington Council of Governments became the coordinating staff for the project, with three full time staff. The project was initiated in 1987 with an inventory of restoration opportunities that identified over 440 potential restoration projects of all types --streams, wetlands, and storm water retrofits, including 91 stream restoration and fish habitat enhancement projects. Federal, Maryland, District of Columbia, and county agencies provided grants and in-kind support for the Anacostia restoration. A large number of volunteer organizations provided labor.

Objectives

The 1987 Anacostia Watershed Restoration Agreement created a governmental partnership called the Anacostia Watershed Restoration Committee (AWRC) to address the deterioration of the river. One of the AWRC's first tasks was to develop the *Six-Point Action Plan*, which established six goals and numerous related activities to restore the river, described below:

Goal 1. Dramatically reduce pollutant loads delivered to the tidal estuary to improve water quality conditions by the turn of the century.

- Reduce the volume of combined sewage overflow and sewage leakage from the urban sewer system into the Anacostia and its tributaries.
- Reduce storm water pollutant loading from existing development through implementation of storm water retrofit ponds, marshes and filter systems.
- Limit increases in urban storm water pollutant loads generated from new development in the watershed through the use of appropriate storm water quality and sediment control regulations at new development sites.
- Discourage trash and debris from entering the river system through public education and remove floatable debris found within the system.

Goal 2. Protect and restore the ecological integrity of urban Anacostia streams to enhance aquatic diversity and provide for a quality urban fishery.

- Implement channel and streambank restoration techniques to improve aquatic habitat and channel stability of degraded urban streams.
- Apply land-use controls and appropriate urban storm water and sediment control practices for additional protection within sensitive watersheds.

Goal 3. Restore the spawning range of anadromous fish to historical limits.

- Remove or modify fish barriers to expand the available spawning range of anadromous and native fish.
- Improve the quality of spawning habitat in the lower Anacostia through the installation of instream habitat improvement structures.

Goal 4. Increase the natural filtering capacity of the watershed by sharply increasing the acreage and quality of tidal and non-tidal wetlands.

- Achieve no net loss of wetlands in the watershed as a result of new development and other activities.
- Restore the ecological function of existing degraded wetland areas.
- Create several hundred acres of new wetlands throughout the basin to partially replace the natural filtering capacity lost over time.

Goal 5. Expand forest cover throughout the watershed and create a contiguous corridor of forest along the margins of its streams and rivers.

- Reduce the loss of forest cover associated with new development and other activities through implementation of local forest conservation ordinances and the Maryland 1991 Forest Conservation Act.
- Take full advantage of existing local, state, federal, and private resources to extensively reforest suitable sites throughout the basin.
- Reforest ten linear miles of riparian area along the Anacostia as a first step in creating an unbroken forest corridor from the tidal river to the uppermost headwater streams.

Goal 6. Make the public aware of its key role in the cleanup of the river, and increase volunteer participation in watershed restoration activities.

- Raise the awareness of the public through environmental education regarding its role in the restoration of the Anacostia Watershed.
- Provide the public with opportunities to actively participate in the restoration of the Anacostia.

Only certain of these objectives and sub-objectives directly involve stream restoration. Only stream restoration activities will be addressed in this case study. For the Anacostia project, these activities will include riparian habitat improvement, in-stream restoration (physical changes to and devices in the stream channel), bank stabilization, and riparian revegetation, as well as related planning, administrative and monitoring activities.

Progress

Anacostia watershed restoration projects are in their sixth year in 1994. In Fiscal Year 1993, almost $24 million was earmarked for structural and non-structural improvements in the basin, with approximately $2 to 3 million directed towards stream restoration. Approximately 15 of the 91 stream restoration and habitat enhancement projects were completed by early 1994, and monitoring efforts to evaluate the success of these projects are underway in Wheaton Branch, a tributary to the Northwest Branch of the Anacostia. Not including planning, studies, publications or support, notable past and present progress in Anacostia stream restoration includes:

- Eight stream stabilization projects in the urbanized Watts Branch basin;
- Removal of stream debris in many sub-watersheds using both paid staff and volunteers;
- Channel and habitat restoration in Sligo Creek, Brier Ditch, Quincy Manor, Gum Springs tributary, Paint Branch, Northwest Branch and Greenbelt Park;
- Removal of barriers to migratory fish movement in Northeast and Paint Branches;
- Fisheries restoration projects in several creeks, including Lower Beaverdam creek;
- Prevention of further fish habitat damage through land use controls; and
- Reforestation of eighteen miles of riparian stream bank, including Sligo Creek, Northwest Branch and Gum Springs tributary, and in other areas of the District of Columbia and Maryland, including Prince George's County Parks.

Currently, restoration efforts are beginning to show modest success. Macroinvertebrate populations are increasing, the number of fish species is increasing, and some species are repopulating areas from which they were formerly eliminated.

Restoration Expenditures

Rather than evaluate only the work completed to date, this analysis considers all proposed stream restoration in the Anacostia project, based on estimated budgets over the planned life of the project. An evaluation of two documents, the *Blueprint for the Anacostia*, which describes expenditures to implement the *Six Point Action Plan*, and the *Fifth Annual Workplan for the Restoration of the Anacostia* indicates that, over the course of the project, approximately $12.7 million (1991$) will be expended for stream restoration activities and related planning and monitoring. About three-quarters of this amount is to be spent on in-stream and near-stream restoration such as habitat improvement, stream channel restoration and riparian reforestation (Exhibit 7). This exhibit displays estimated costs for stream restoration planning, staff support, publications, advertising, coordination and supervision by evaluating these cost categories for the larger project as a whole, and attributing a portion to stream restoration, based upon stream restoration's identifiable proportion of total Anacostia project costs in Fiscal Year 1993.

Exhibit 7. Anacostia Estimated Planned Expenditures

	1993 Categorical	Percent of Annual	Planned Expenditures (1991$)
Planning and Staff Support	$201,667	7%	$847,000
Coordinators/Supervisors	$40,950	1%	$172,000
Monitoring and Reporting	$233,000	8%	$979,000
Publications/Advertising	$214,945	7%	$903,000
Habitat Improvement &	$2,266,000	75%	$9,519,000
Riparian Reforestation	$75,000	2%	$824,000
Total Restoration Activities	*$3,031,562*	*100%*	*$12,735,000*

Employment Creation

To assess the economic and employment effects of Anacostia restoration, the identified activities of the project were compared to the template created in IMPLAN for the state of Maryland (see Appendix B). Some restoration project descriptions matched the template's activities closely, while others were a composite of activities in the template. Where the activities matched closely, (e.g. reforestation) the template activity jobs[7]/$mm spent was multiplied by expenditures to estimate jobs (direct, indirect and induced); in other cases a weighted average of the job creation effects of activities used in the project were multiplied by actual and anticipated expenditures.

Over the life of the Anacostia project, expenditures on non-structural stream restoration activities can be expected to create an estimated total of 454 jobs in the state of Maryland[8]. As Exhibit 8 illustrates, two hundred and eight (208) of these jobs will be direct jobs created by the project, with 155 of these associated with in-stream or near-stream restoration activities, and another 54 jobs involved in planning, monitoring, or publication and advertising.

These direct employment numbers underestimate the total activity in the stream corridor, due to the large volunteer component of the restoration effort. However, although volunteers may contribute their own tools and may cause an increase in supervisory/managerial expenditures, volunteer effort will have negligible incremental expenditure effects in the regional economy. The real beneficial effect of volunteers is that they create value and increase the benefits potentially provided by the stream resource over time, such as increased commercial or sport fishing in the Chesapeake some years into the future. While real, these effects are too distant and uncertain to evaluate in this analysis.

Exhibit 8. Anacostia Employment Creation

Activities	Direct Jobs	Indirect Jobs	Induced Jobs	Total Jobs
Planning and Staff Support	16	1	13	30
Coordination/Supervision	3	0	3	6
Monitoring and Reporting	20	1	15	36
Publications/Advertising	18	1	14	33
Habitat Improvement and	138	40	141	319
Riparian Reforestation	13	5	12	30
Total Jobs	***208***	***48***	***198***	***454***

Another 48 jobs are estimated to be created indirectly in industries supplying equipment and products to the restoration effort. The majority of the indirect jobs in Maryland are for suppliers of tools, equipment and materials used in in-stream activities, such as nursery products, construction equipment, rebar, fencing, logs, sand and gravel.

An estimated 198 jobs could be created in Maryland's economy over the life of the project as a result of the respending of direct and indirect wages from restoration activities. Most of these are in labor

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[7] One job, or job-year is equal to one full year of employment for one person

[8] Maryland is the location of all stream restoration projects; while planning jobs may occur in Maryland, D.C. or Virginia, the jobs were allocated to Maryland for simplicity, and because the difference on the estimated total number of jobs when surrounding regions were included were determined to be negligible.

intensive service industries such as housing, food services, and banking, which is a typical pattern for consumption expenditures.

A restoration output multiplier was estimated for the state of Maryland based on a composite of the expenditures made on restoration in the Anacostia River Basin. The composite total output multiplier equals 3.4, indicating that the $12.7 million of direct program expenditures on Anacostia stream restoration would generate a total value of about $43 million of increased economic activity in Maryland. While this multiplier is high compared to investments in many industries, restoration is labor intensive and the personal consumption expenditures from increased wage earnings generate high levels of in-state economic activity.

Discussion: Population and Unemployment

To date, the physical work of the Anacostia stream restoration effort has been located in Montgomery and Prince George's Counties, Maryland, although considerable planning, supervisory and coordination work has been done in the District of Columbia, as well as Maryland and Virginia. Prince George's County had a 1992 labor force of 429,000 and an average 1992 unemployment rate of 5.7 percent. Montgomery County had a 1992 workforce of 438,000 and an average 1992 unemployment rate of 3.7 percent, while Maryland's overall unemployment rate was 6.6 percent. The District had a 1992 workforce of 276,000 and an unemployment rate of 8.4 percent. Virginia's unemployment rate for 1992 was 6.4 percent. These compare to average U.S. unemployment of 7.4 percent in 1992 (6.8 percent in 1993).

Assuming no labor mobility, the job creation effect of stream restoration would be most beneficial in Prince George's County and Washington, DC. However, workers are mobile within the area and jobs created in Prince George's or Montgomery counties are also likely to employ residents from Maryland, Washington, DC, and Virginia as well. Job creation would benefit the metropolitan area as a whole to the extent that real unemployment exists. Some economists suggest that there is a "natural" level of unemployment of approximately 4 percent which is composed of the unemployable and people in transition (although other economists claim the natural unemployment rate could be as high as 6 percent). If unemployment falls below these levels, economies could begin to overheat (increased labor demand causes wage rates to rise without corresponding increases in production) and become inflationary. With the exception of Montgomery County, the unemployment levels in the metropolitan Washington region are significantly above the natural level, indicating that any new jobs created would likely provide net employment to someone currently unemployed.

Another perspective on unemployment is a more specific look at the type and value of jobs created. While considerable stream restoration planning and supervision require trained biologists and engineers, much of the in-stream, physical restoration work is often done by young adults (either volunteers or employees), with little initial experience. Nationally, the unemployment rate for individuals 16 to 19 years of age was about 19 percent in 1993, with the average even higher in urban areas and in areas with a high proportion of racial minorities - overall minority unemployment was about twice the rate of white unemployment in 1993. Restoration can provide not only jobs to these underemployed groups, but also skills that will be useful in future restoration projects if the demand for restoration grows as anticipated.

Exhibit 9. Participating Organizations

Metropolitan Washington Council of Governments (COG) is the regional planning agency for the local governments and officials of the Washington, D.C. area. It is responsible for providing administrative and technical support for the restoration activities of the Anacostia Watershed Restoration Committee (see below).

U.S. Army Corps of Engineers (USACE) is involved in the design and management of a variety restoration projects including fish passage, in-stream habitat improvement, and reforestation. USACE also designs wetland protection plans for the watershed.

U.S. Environmental Protection Agency (EPA) funds and executes direct stream restoration projects as well as other watershed projects such as storm water control.

Interstate Commission on the Potomac River Basin (ICPRB) is responsible for coordinating and implementing public education activities for the watershed.

U.S. National Park Service (NPS) works on in-stream habitat restoration and reforestation for the Anacostia River, and also provides wetlands creation/protection services.

Maryland Department of the Environment (MDE) coordinates restoration activities in the state of Maryland and provides services for riparian reforestation and habitat improvement.

Maryland Department of Natural Resources (MD-DNR) is involved in the management of in-stream restoration projects, reforestation efforts, fish passage programs, and other watershed improvement actions.

Maryland National Capital Park & Planning Commission (MNCPPC) undertakes all types of restoration projects within Montgomery and Prince George's Counties. The Commission designs in-stream and riparian projects, and also provides storm water control, wetland protection, and other services in the Anacostia Watershed.

Montgomery County Department of Environmental Protection (MC-DEP) handles restoration projects including in-stream habitat improvement and reforestation in Montgomery County.

Prince George's County Department of Environmental Regulation (PG-DER) handles restoration projects including in-stream habitat improvement and reforestation in Prince George's County.

District of Columbia Department of Public Works (DC-DPW) manages a variety of restoration efforts in the District of Columbia. The Department is involved in habitat improvement and reforestation of the streams, along with wetland restoration and storm water control.

District of Columbia Department of Consumer and Regulatory Affairs (DC-DCRA) focuses on in-stream habitat restoration and protection in the District of Columbia.

Anacostia Watershed Restoration Committee (AWRC) is a committee that was formed in 1987 by the Anacostia Watershed Restoration Agreement, which was signed by the state of Maryland, Montgomery County, Prince George's County, and the District of Columbia. AWRC is responsible for developing restoration plans and coordinating the efforts of other involved agencies.

Anacostia Watershed Society is one of many nonprofit, private organizations that provides services in the watershed. The Society is involved in trash and debris removal, riparian planting, and public outreach.

BOULDER CREEK, BOULDER, COLORADO

Boulder Creek, Colorado, flows eastward from the foothills of the Rocky Mountains through the City of Boulder and into agricultural areas east of the city. To renew the National Pollution Discharge Elimination System (NPDES) permit for discharging effluent from its wastewater treatment plant (WWTP) in 1985, the City of Boulder was required to develop and implement a plan to reduce levels of ammonia in the creek, and achieve other water quality standards. Over time, the stream was subjected to various environmental stresses in and around the City of Boulder, including: urban and agricultural runoff, effluent discharges from municipal wastewater, urban development, and loss of vegetation, shading, pools and other desirable habitat characteristics. These sources of stress cumulatively limited the stream's ability to support a healthy aquatic community.

Boulder Creek drains approximately 440 square miles of the eastern side of the Colorado Rocky Mountain Front Range. Upon emerging from the mouth of Boulder Canyon, the stream flows through the urbanized center of the City of Boulder and begins a transition from a cold water (< 20 degrees Celsius) to a warm water (>20 degrees Celsius) ecosystem. The transition between cold and warm is completed at the WWTP approximately 8.3 miles from the mouth of Boulder Canyon. Much of this reach includes properties under easement to the City of Boulder that are part of the city's Open Space Greenbelt program. Boulder Creek joins Coal Creek at 8.5 miles and St. Vrain Creek at 15.5 miles downstream of the WWTP, before flowing into the South Platte River. Land uses along the reach between the WWTP and the Coal Creek confluence range from city-owned greenbelt to the city to privately-owned agricultural operations. The remaining 7.0 miles between Coal and St. Vrain Creeks is dominated by irrigated agriculture and gravel mining.

The Problem

The City of Boulder's water quality laboratory found excessive levels of un-ionized ammonia occurring daily in Boulder Creek during the spring months of March and April and late summer/fall months of August, September, and October. City and state officials were concerned because high levels of un-ionized ammonia are toxic to aquatic life and such levels exceed the State of Colorado's water quality standards. Data collected at the WWTP showed the plant was meeting its effluent limits for un-ionized ammonia, indicating either that the effluent limits were insufficiently stringent, or that other factors were responsible for the high ammonia levels. As the City's WWTP was at 80 percent of capacity and required modification and upgrades in any case, it was determined to add a nitrification trickling filter (NTF) tower to convert un-ionized ammonia into nitrate. The NTF was included as a condition of the City's NPDES water quality discharge permit, in addition to normal secondary treatment requirements for turbidity and fecal coliform. Should un-ionized nitrate levels increase, additional NTF's may be required at the expiration of the current permit in 1998.

Recently, the community of Lafayette, downstream from Boulder, has indicated its interest in using Boulder Creek as a supplemental potable water source. Nitrate, converted from un-ionized ammonia by the NTF, is a regulated pollutant under drinking water standards. Should additional NTF's be required to reduce the aquatic toxicity of un-ionized ammonia, nitrate levels could approach or exceed drinking water standards, potentially requiring the City of Boulder to add costly denitrification treatment at the WWTP. Boulder was interested in finding other, more cost-effective and environmentally beneficial means of reducing un-ionized ammonia levels.

Investigation revealed other, more significant causes of the un-ionized ammonia levels in the stream. High water temperature, as well as algal growth resulting from a high (basic) pH downstream from the WWTP, fostered the generation of toxic un-ionized ammonia. The high water temperatures were caused by poor stream configuration, and the high pH by nonpoint pollution. Lower Boulder Creek is wide and shallow from channelization and lacks adequate instream habitat (pools, riffles and meanders) and shading. These conditions resulted in high water temperature and a heavy growth of instream aquatic vegetation, which fostered conversion of total ammonia to toxic un-ionized ammonia. Irrigation return flows also contributed to the poor water quality. A significant downstream rise in pH from 7.0 (neutral) at the WWTP outfall to as high as 10.0 at a point 8.5 miles downstream, suggested both nonpoint sources of pollution and adverse stream conditions downstream from the outfall.

Lower Boulder Creek basin nonpoint source problems included:

- Runoff from highway, street, and road sanding operations;
- Nonpoint sediment drainage from ditches, gravel mining areas, irrigation return flow ditches, and storm sewers;
- Historic channelization (straightening and shortening the stream channel and creation of a wider, shallower streambed), livestock grazing, and streambank erosion; and
- Destruction of riparian vegetation and habitat by road building, sand and gravel mining, firewood cutting, and livestock grazing.

City officials concluded that neither additional WWTP upgrades (estimated at $23 million) or nonpoint source controls individually could provide desirable aquatic habitat and water quality standards. They also concluded that they could not justify the cost to produce a high quality effluent from the WWTP just to release it into a stream that was physically degraded and polluted by nonpoint sources. To determine in more detail what could be done to alleviate the water quality problems, the City initiated a number of environmental studies of the Creek between 1985 and 1988 (See references 2, 3, 4, 5, 6 as indicated below). Those investigations included:

- A habitat study (of a 15.5 mile reach downstream of the WWTP) which documented physical habitat characteristics and modifications, including irrigation diversion dams and return flow ditches, riparian and aquatic vegetation, macroinvertebrate and fish community structure and function, land use practices, abnormally high temperatures and nonpoint source pollution (2).
- An 18-month, biweekly, and 24-hour sampling study which documented water quality at the Boulder Creek/Coal Creek confluence (3, 4). Un-ionized ammonia excursions were observed primarily during spring and fall and during daylight hours between 10:00 a.m. and 6:00 p.m. These excursions were influenced strongly by fluctuations of pH and temperature in the water, which influenced the conversion of total ammonia present in the stream to the toxic un-ionized form.
- A spring and fall 24-hour study which identified the extent of the seasonal un-ionized ammonia excursions (5). This study confirmed that daily fluctuations in pH and temperature in the creek had a profound impact on the conversion of total ammonia in the water to its toxic un-ionized form.

A 1987 report for the City by Aquatic and Wetlands Consultants, Inc. (AWC) indicated that it would be feasible to use riparian and aquatic habitat restoration to lower the Creek's temperature and pH and thereby reduce un-ionized ammonia levels (6).

In particular, the AWC report proposed the use of selected best management practices (BMPs) to reestablish the riparian function in affected stream segments and to control nonpoint stressors. These activities would complement the advanced secondary wastewater treatment and denitrification recommended by the city's wastewater facilities plan. Findings of the AWC report concluded that implementation of several BMPs could help to alleviate the following problems:

- Fluctuations in pH during the spring and fall could be reduced by reducing photosynthesizing aquatic vegetation;

- Excessive sediment inputs, resulting from rapid erosion of unstable stream banks, could be mitigated by restoration of riparian vegetation, revetment of streambanks, and detention of return water from irrigation ditches or gravel mining areas;

- Oxygen and carbon dioxide levels could be increased by rock aeration structures and modification of diversion dam plunge pools;

- Grazing impacts could be controlled by appropriate use of fencing to exclude cattle from riparian habitat (installing high tensile, wildlife compatible fencing); and

- Overhead canopy density and its shading function could be restored over time by planting willow and cottonwood species appropriate to the area.

Moreover, the consultant's feasibility study suggested that rehabilitating the creek's biology and hydrology might save the city money in the future by eliminating the need for expansion and upgrade of the WWTP with additional denitrification towers. Stream restoration would not only improve water quality but also diminish the toxic effect of the ammonia found in Boulder's wastewater discharge.

In 1989, city and state officials conducted a one-day field trip between the WWTP outfall and St. Vrain Creek 15.5 miles downstream that confirmed the reported water quality problems. The field trip and the consultant's report provided the impetus for the city to take action. Based on the evidence from its accumulated studies, the city expanded and upgraded the WWTP (with one denitrification tower) to meet NPDES water quality standards (a $23 million plant expansion and upgrade was completed in January 1989), and then, began the phased nonpoint source (restoration) demonstration project which would defer more expensive modifications at the treatment facility.

The Boulder Creek Nonpoint Demonstration Project

The overall goal of the demonstration project is to improve the water quality and habitat characteristics of the stream and avoid or defer the need for additional and expensive treatment (denitrification). The restoration best management practices below the WWTP outfall are expected to increase the capacity of the stream to assimilate ammonia. The stream restoration work was designed to be compatible with and complement advanced secondary wastewater treatment at the WWTP. A secondary goal is to implement and evaluate the environmental outcomes of selected stream restoration BMPs.

Additional project goals are to: 1) control nonpoint source pollution by riparian and aquatic habitat restoration; 2) reduce instream pH, temperature, and seasonal un-ionized ammonia excursions; and 3) achieve desirable habitat characteristics. These goals will be achieved by:

1. Stabilizing eroded streambanks;
2. Restoring riparian habitat function;
3. Increasing pool habitat;
4. Narrowing a highly modified channel;
5. Treating irrigation return flows by wetland filtration;
6. Modifying diversion dams to facilitate fish spawning success; and
7. Restoring wetland habitat.

Planning

Not including the studies noted above, project planning and design began in 1989 and continued through 1994. For each phase, planning and design occurred prior to any actual instream activities, although the design of later phases built on lessons learned in the earlier phases. Techniques developed during the initial phases were improved and employed in later planning and implementation. Planning participants included the City of Boulder and Aquatic and Wetland Consultants, Inc., under contract to the city. The project team included the project manager, an aquatic ecologist, a hydraulic engineer, and a construction supervisor, all of whom participated in the design and subsequent construction process. The planning process required approximately 10 full-time equivalents (FTEs), or job-years, at a total cost of about $255,000, or about thirty four percent of project cost.

In-Stream Activities

Actual site work on the Boulder Creek project began in 1989 when the City of Boulder received a 60/40 matching grant from the *Colorado Nonpoint Source Program*. Work is scheduled to continue through 1998. The project involves a total of 4.6 miles of physical, biological, and chemical habitat restoration using state-approved BMPs along Lower Boulder Creek, from the city's 75th Street Wastewater Treatment Plant (WWTP) to the confluence with Coal Creek in Boulder County. The project is comprised of four phases:

1) Phase I, which was completed in the spring of 1990, consisted of 1.3 miles of discontinuous stream restoration improvements. Six BMPs were designed and constructed below the WWTP, including restoration of riparian vegetation to allow the riparian area to filter pollutants in overland sheet flow runoff, and fencing to exclude cattle and cattle waste from the stream.

2) Phase II, which was completed in the spring of 1991, affected an additional 1.1 stream miles. Installed BMPs included creation of wetland detention systems to filter pollutants concentrated in irrigation return flows (to solve problems caused by a year-round irrigation return flow ditch).

3) Phase III BMPs, completed in the spring of 1992, reduced the impact of surface gravel mining through streambank stabilization, revegetation, and creation of wetlands. The project used abandoned gravel pits as small settling basins, from which runoff spills over into wetlands and finally into the creek.

4) Phase IV, which is currently in the final design stage with construction scheduled to begin in the fall of 1994, will include improvements to the stream channel and riparian and aquatic habitat restoration. It will also provide for maintenance and improvements to the three previous project areas to increase their effectiveness. (Phase IV was originally scheduled for completion in the spring and fall of 1993. Work could not begin until the spring months have passed, to avoid construction disturbance of a heron rookery during the breeding season.)

Each phase of the Boulder Creek project has included a post-project review to evaluate the success of design, materials, and construction methods. Results of these evaluations have been put to use in subsequent phases. For example, planting and harvesting techniques were altered from Phases I and II and these modifications enhanced the survival of riparian plantings.

The phased, sequential progress of the project allowed introduction of design changes to improve the effectiveness of BMPs, which is an important element of the project's success. In other words, the specific activities included in BMPs (particularly for revegetation of the riparian zone) have changed over time, which implies that costs for certain BMPs have also changed.

Since the Boulder Creek project began, instream monitoring has included monthly sampling for water quality, flow, and temperature, as well as fish inventories and evaluation of canopy density, ground water levels, and physical habitat. Some of this monitoring has been conducted by students. The City of Boulder has conducted a monthly monitoring program at several stations for some time and these results will be used as a benchmark against which all future data can be compared.

Post-Project Monitoring

In addition to the on-going monitoring activities, a detailed monitoring project began in early 1994 to assess the success of project phases I, II and III. In March 1993, the City of Boulder submitted an $84,856 funding request to EPA for the first year of a proposed five-year monitoring program at the 4.6 mile Boulder Creek Nonpoint Source Demonstration Project (7). The City of Boulder allocated $25,000 toward the first year of the monitoring program and the University of Colorado committed additional support in the form of in-kind services (office space, secretarial, library and computer services). In early 1994, Aquatic and Wetland Consultants received a grant from EPA for $30,000 for the first four months of monitoring, which will fund one person working full time.

The City of Boulder is also pursuing other projects to curtail nonpoint source pollutant loading in the Boulder Creek watershed. Among them are highway, storm water and urban runoff projects and the city's "Tributary Greenway" project that filters sediment through a bikeway/buffer strip along secondary streams and creeks.

Activities

A total of twelve different BMPs were implemented during Phases I through III and more of the same BMPs will be implemented in Phase IV (Exhibit 10). The twelve BMPs are grouped into three major

Exhibit 10. Nonpoint Problems and Restoration Activities (BMPs)

NONPOINT SOURCE	BMPs
Category 1: Riparian Habitat	
Overland Flow	Fencing to exclude cattle and cattle waste from the creek and riparian habitat
	Revegetation Planting/Seeding to provide riparian habitat and eventually shading to decrease stream temperatures and moderate stream pH levels
	Channelized Berm Removal to replace berms with terraced streambanks so that vegetation would be closer to the water table
Streambank Erosion	Log Revetment to stabilize highly erosive streambanks
	Jetties extending into stream to dissipate erosive force, stabilize highly erosive streambanks and reduce sediment
	Brush Layering
	Wattling
	Boulder Toe/Brush Bundle
Category 2: Aquatic Habitat	
Excessive Width and Shallow Depth/Aquatic Weeds	Narrow Channel with Low Flow Pool/Point Bar/Tailout (to concentrate and deepen water flow to reduce the growth of photosynthesizing aquatic vegetation encouraged by excessive channel width and shallow depth)
Flat Water	Rock Aeration Structure (to increase dissolved oxygen and carbon dioxide levels)
Diversion Dams	Fish Passage Structure (to modify irrigation diversion dams to allow fish passage and encourage fish spawning success)
Category 3: Water Quality	
Irrigation Ditch Return Flows	Wetland Habitat Enhancement (existing and constructed wetlands are being utilized to treat very low quality and sediment laden agricultural irrigation ditch return flows)

categories, based on project objectives. The BMPs were intended to control nonpoint source pollution, result in physical, biological and chemical restoration, and facilitate attainment of the aquatic life use. Exhibit 10 outlines the three major categories, and the BMPs within each category. The monitoring project is just underway, and definitive results are not yet available.

<u>Financing</u>

EPA initially provided a Section 319 grant to the State of Colorado, which passed through federal funds to the City of Boulder, supplemented by support from the city, the University of Colorado, and local consultants. EPA also provided funding to Boulder to support instream monitoring and development of a water quality model.

On-the-ground expenditures for the first three phases, i.e., exclusive of planning and design work, totaled $384,000, funded by a 60/40 match between a federal grant and the city. The grant focused on using BMPs to attain the state-designated *Warm Water Aquatic Life Use* classification. Implicit in attaining

these "life use classifications" is the presence of indicators of adequate habitat quality to support fauna and flora typically found in similar natural stream systems. Colorado provided 60 percent of the needed funding under the state's nonpoint source control program; the remaining 40 percent was provided by the City of Boulder. Expected cost savings from avoiding the need to construct additional denitrification towers for the WWTP induced the City to contribute a significant portion of the funding.

Project Costs

Exhibit 11 shows actual expenditures by type, year and project phase for the Boulder Creek restoration project. These costs provide the basis for the following employment analysis. Total funding for on-the-ground expenditures for Phase I was about $124,000. Phase II funding for on-the ground expenditures was about $127,000, Phase III was funded for $133,000. Total on-the-ground expenditures for the first three phases is $384,000. Phase IV is estimated to have a budget of $191,000, including $85,000 for monitoring.

The most significant cost categories are design (35 percent of total) construction (21 percent), fencing (9 percent), revegetation (9 percent) and monitoring (11 percent). Design costs could be expected to decline on future projects, both as a percent of total costs and overall, as accumulated knowledge and success reduce uncertainty and make planning easier.

Exhibit 11. Boulder Creek Project - Phased Costs

Activity	Phase 1 1989	Phase 1 1990	Phase 2 1991	Phase 3 1991	Phase 3 1992	Phase 3 1993	Phase 4 1994	Total	% of Total
Design Costs		$63,000		$57,445	$32,984		$106,000	$259,42	35%
Revetment/Rip	$10,505							$10,505	1%
Construction	$49,106		$46,116		$48,163	$17,523		$160,90	21%
Rock & Hauling			$8,886		$12,000			$20,886	3%
Fencing	$36,000	$7,201	$22,084			$1,909		$67,194	9%
Revegetation		$20,964	$46,116					$67,080	9%
Diversion			$1,766					$1,766	0%
City Staff	$1,285	$6,193	$6,815	$1,531	$6,895			$22,719	3%
Maintenance			$2,380			$53,087		$55,467	7%
Monitoring							$85,000	$85,000	11%
On-Site costs	$95,611	$28,165	$127,346		$60,163	$72,519	$85,000	$468,80	62%
Off-Site Costs	$1,285	$69,193	$6,815	$58,976	$39,879		$106,000	$282,14	38%
Total Costs	**$96,896**	**$97,358**	**$134,161**	**$58,976**	**$100,042**	**$72,519**	**$191,000**	**$750,95**	**100%**

Project costs include the costs of gathering data for planning and evaluation, construction, materials, and labor. Not considered in this analysis is the augmentation of the project's value through donated labor, time and materials. Sources indicate that donations total about $250,000 for Phases I and II. In Phase I, a limited easement that covered more than 40 acres was donated by the owner of a cattle ranch along the creek.

Exhibit 12 displays project costs in constant 1991 dollars and rearranged to fit the stream restoration IMPLAN input-output model for Colorado. The modifications include: "*Adding meanders*" includes the Boulder Creek project costs for diversion and one-third of construction costs; "G*rass seeding*"

and *"Planting shrubs"* each include twenty-five percent of the costs of revegetation, with the other fifty percent included in *"Planting trees"*. *"Planting trees"* also includes one third of general construction costs. The final third of the project's construction costs are included under *"Placement of boulders"*, as are the costs of rock and hauling. Planning, design and city staff costs are calculated as "state and local" expenditures in the IMPLAN model.

Exhibit 12. Boulder Creek Expenditures by I-O Category (1991 dollars)

Restoration Activities	Expenditures
Adding Meanders	$56,079
Fencing	$69,833
Grass Seeding	$16,880
Placement of Boulders	$75,054
Planting/Shrubs	$16,880
Planting/Trees	$88,237
Rip-Rap/revetment	$11,254
Maintenance	$53,293
Planning & Design	$252,571
Management & Budget	$22,857
Monitoring	$78,763
Total	***$741,701***

Potential Savings

The total cost of this project, when completed, is estimated to range between $1.4 million and $4.4 million based on a number of unknown land acquisition costs. With a 20 percent margin for contingencies and an additional 15 percent for engineering, legal and administrative expenses, the total cost of the project is estimated between $2 million and $6 million. Long-term denitrification costs for the wastewater treatment plant are estimated to be approximately $8.7 million. As a result, there is a potential cost savings of at least $2.7 million associated with implementing the restoration project, presuming it is successful.

Employment Creation

Analysis of the employment effects of the Boulder Creek Project was enhanced by a reasonably close fit between the project's activities and the Colorado IMPLAN model (i.e., the national model fitted to Colorado state data). Exhibit 13 shows the timing of employment creation for the Boulder Creek project. There is a higher level of employment (as a result of expenditures) in the construction, and monitoring and maintenance phases of the project. Some of the jobs shown in 1994 may be created in 1995. With this, the project's employment is relatively constant, ranging between three and six job years each year.

Exhibit 14 illustrates the direct, indirect and induced employment that is estimated to be created as a result of this project. Approximately thirteen direct jobs are created over the life of the Boulder Creek project. These include six office jobs for planning, design and management, and seven stream corridor jobs.

Exhibit 13. Boulder Creek Project: Timing of Employment Creation

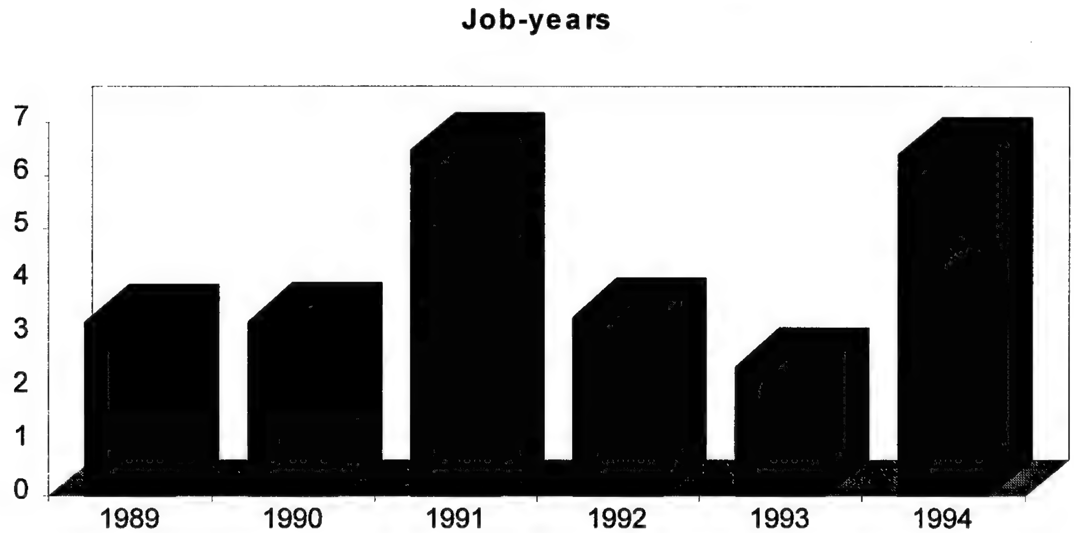

Exhibit 14. Boulder Creek Input-Output Model Employment Results

Restoration Activities	Expenditures	Direct Effects	Indirect Effects	Induced Effects	Total Effects
Adding Meanders	$56,079	0.81	0.25	0.89	1.95
Barbed Wire Fencing	$69,833	1.11	0.28	1.00	2.39
Grass Seeding	$16,880	1.17	0.20	1.07	2.44
Placement of Boulders	$75,054	0.26	0.10	0.27	0.62
Planting/Shrubs	$16,880	0.53	0.42	0.74	1.69
Planting/Trees	$88,237	0.22	0.13	0.25	0.60
Rip-Rap/Revetment	$11,254	1.39	0.42	0.70	2.50
Maintenance	$53,293	0.05	0.07	0.09	0.20
Planning & Design	$252,571	5.43	0.58	4.10	10.11
Management & Budget	$22,857	0.49	0.05	0.37	0.92
Monitoring	$78,763	1.69	0.18	1.28	3.15
Total	***$741,701***	***13.2***	***2.7***	***10.8***	***26.6***

Indirect employment in nurseries, quarries and equipment suppliers approximates 3 jobs over the life of the project. Anecdotal evidence suggests these results (derived from IMPLAN) may underestimate the indirect employment due to some unique project circumstances. This project required specialized materials and services. The consultants overseeing the project, AWC, attempted to revegetate the stream corridor with native plant stock. However, as a commercial supply of these materials was not available, the company started its own subsidiary nursery to grow and supply native plants, creating indirect jobs in the process. Some portion of these jobs can be attributed to other projects that use the nursery's products,

but this project was the driving factor in its establishment. Similarly, another off-shoot of the project was the development of a unique construction company (a spin-off of AWC) that provides the specialized in-stream construction needed to restore stream habitat and hydrology. While the activities of the company are included under direct effects, indirect jobs are created at their vendors.

An estimated 11 induced jobs will be or have been created in Boulder, Denver and environs, as Boulder Creek project workers spend their wages on groceries, rent and other products and services. Moreover, insofar as the project saves Boulder sewer and/or water ratepayers the costs of adding denitrifying towers, (the $2.7 million noted above), that money will remain in the local economy, creating employment through induced (respending) effects (up to 54 additional jobs). Not counting the jobs created as a result of savings, an estimated total of 27 jobs will be created as a result of this project.

Discussion: Demographic Considerations

If one assumes a "natural" rate of unemployment of 4%, the unemployment level in Boulder and in Colorado (6 percent and 6.5 percent, respectively) is measurably above that, indicating the jobs created by the Boulder Creek project may be "net" jobs, rather than displacement from other industries or activities. Moreover, like other restoration projects across the country, the Boulder Creek Project may create employment for some chronically underemployed segments of the populations. Reports from project managers indicate that a high proportion of the on-site project labor was provided by temporary laborers, secured either through local newspaper advertisements or through temporary employment agencies. A high proportion of these -- in this and other similar projects -- were minorities, homeless men, or unemployed individuals from rural areas. One of the most important results of this and other restoration projects may be the skill-building effect that these projects potentially give to consistently unemployed or underemployed individuals. One formerly homeless man (a temporary worker) became a full-time employee and crew leader for over a year.

GLEN CREEK, DENALI NATIONAL PARK AND PRESERVE, ALASKA

Background and Problem

The Alaska National Interest Lands Conservation Act (ANILCA) of 1980 established 10 new National Park units and enlarged two existing units in Alaska, which added 54 million acres to the U.S. National Park System. ANILCA requires the National Park Service (the NPS) to manage and protect the natural resources within national parks in Alaska. While much of the ANILCA land is remote and largely untouched, a number of streams within the park system have been significantly degraded by placer and lode mining. Over 3,000 acres of surface disturbance and 60 miles of mined streams exist in these parks.

A 1985 court order directed the NPS to stop approving mining plans of operations in three Alaska national park units -- Denali National Park and Preserve (Denali NPP), Yukon-Charley Rivers National Preserve, and Wrangell-St. Elias National Park and Preserve, and to prepare an environment impact statements (EIS) on the cumulative impacts of mining. The final decision of the EIS was to acquire mining claims and proceed with reclaiming mine-disturbed lands as funds became available. In Denali NPP, there are at least 22 patented and 180 unpatented placer mining claims located in the Kantishna Hills area. Many claims are placer mining claims, where miners divert the stream and remove the vegetation, topsoil and overburden from the old streambed which is to be mined. Gravel is excavated and mixed with water and the mixture is then directed through a sluice box, where gold and sand settle and gold is extracted. The turbid water flowing from the end of the sluicebox is routed into settling ponds.

The Kantishna Hills Study Area comprises 255,247 acres (352 square miles) of the 6,770 square mile Kantishna watershed. Vegetation in Denali NPP is typical of interior Alaska taiga, with lowlands covered by dense spruce and poplar, open upland forests of spruce, birch and aspen, and floodplains sparsely vegetated with willow, poplar and alder. Outside of the study area, the Kantishna River is fed largely by turbid glacial streams originating in the Alaska Range. By contrast, streams entering the Kantishna River from the Kantishna Hills, fed by clear waters derived from rain, snow melt, and subsurface aquifers, are uniquely well oxygenated and fast flowing, and are, therefore, important habitat for several native fish species (sixteen species occur in Denali NPP). Arctic Grayling is the primary sport fish in the park, and is important for sustenance and sport throughout Alaska. Historically, Kantishna Hills streams supported abundant populations of grayling, which have been diminished as a result of placer mining operations.

Glen Creek Stream Restoration Project

The NPS selected a 2-mile section of Glen Creek, one of 13 drainages disturbed by mining activities in the Kantishna Hills Study Area, for one of the most extensive watershed research and restoration projects in Alaska. The Glen Creek restoration site was selected for three reasons: first, it was accessible by surface vehicles, second, the NPS owned both the surface and subsurface rights to Glen Creek, and, third, the site had been extensively disturbed by mining. Much of the riparian disturbance along Glen Creek was attributable to placer mining for gold. Land status was (and remains) a major factor in determining which sites were selected for restoration within Denali NPP. The NPS cannot perform restoration work on patented mining claims, which are private property and are not under NPS jurisdiction, although they are within Denali NPP's boundaries. The NPS currently chooses not to perform restoration work on unpatented claims because of the possibility of future mining. If not maintained, ownership of unpatented claims reverts to the NPS, which occurred at Glen Creek.

Glen Creek and its tributaries drain a watershed of 4,353 acres. Nearly the entire drainage of Lower Glen Creek - 5.7 stream miles - has been disturbed extensively by mining activities, which began in the early 1900s and continued through the early 1980s. The disturbed stream sections along Glen Creek characteristically lack riparian vegetation or pools, and the original stream channels and floodplains have been modified or destroyed. Mining equipment has been abandoned within and alongside stream channels. Tailings piles (where excavated material is dumped) and filled settling ponds are infrequently and poorly graded or revegetated. Erosion of unstable, sparsely vegetated streambanks and tailings piles causes stream sedimentation and alteration of substrate composition downstream of mined areas. Increased sediment in the substrate adversely affects fish egg development and invertebrate production. Streams and stream sections that have been extensively disturbed generally contain the lowest quality fish habitat. The cumulative effects of mining are poor water quality, poor aquatic and riparian habitat, and reduced fish populations.

Project Initiation and Planning

During the Lower Glen Creek Restoration Project - from 1987 to 1992 - the NPS staff at Denali NPP and the Alaska regional office prepared a project plan and three Environmental Assessments (EAs) - two for reshaping and stabilizing the stream channel and floodplain, and a third for grading tailings piles and removing mining debris. As noted above, in addition to restoring the stream, the Glen Creek Project was designed as a laboratory for researching the effectiveness of stream restoration approaches in Alaska's extreme climate and fragile ecosystem. Initial project planning efforts focused on both research and restoration priorities.

Project planning involved a project team from Denali NPP and the Alaska Regional Office of the NPS as well as consultation with other state and federal agencies. The Glen Creek team, which consisted of three ecologists and a hydrologic engineer had primary responsibility for planning and implementing the Glen Creek project. Other agencies served in the following supporting roles:

- The U.S. Fish and Wildlife Service evaluated the project's estimated effects on threatened and endangered species;

- The U.S. Army Corps of Engineers issued a dredge and fill permit (Section 404 permit) for work to reroute the stream in the floodplain;

- The U.S. Geological Survey, through an interagency agreement with the NPS, collected and analyzed data throughout the Kantishna Hills Study Area to establish a baseline for monitoring recovery of mined and unmined streams for aquatic life;

- EPA reviewed the project because the restoration work initially resulted in increased sedimentation in Glen Creek;

- The Alaska Department of Fish and Game reviewed the project and provided clearance; and

- The Alaska Department of Environmental Conservation issued a permit to burn abandoned plywood shacks at the restoration site.

A long-term and complex research and restoration project like the Glen Creek Project requires substantial advance planning and design, particularly since the time available for on-site work is limited by the climate. NPS staff estimate that the lower Glen Creek Project required between one and one-and-a-half full time equivalents for planning and design over the life of the project.

Restoration Objectives

The project team established a primary project goal to re-establish natural ecological processes so that Lower Glen Creek will eventually function as a natural system. The team wanted natural plant succession to begin, and focused on the floodplain and the entire watershed. The principal restoration activities included:

- Clean up and removal of abandoned buildings, trailers, miscellaneous equipment, and trash, which were burned or hauled away for recycling.
- Regrading and revegetation of tailings piles;
- Reshaping the stream channel and revegetating and stabilizing the floodplain and streambanks;

Re-establishment of streambank and floodplain vegetation is a crucial component of restoration success in Denali NPP's short growing season and shallow soils. Various revegetation research proposals developed by the Glen Creek restoration team were incorporated into one large revegetation proposal for the project. Because the NPS has a policy to introduce no foreign species into national park sites, on-site genetic material was selected for revegetation efforts. Revegetation began with collecting seeds from the site in the fall. The seeds were grown in the Alaska State Forestry Lab for one to two years and then the NPS took the seedlings to the restoration site and reimbursed the Forestry Lab for growing them.

No in-stream restoration work (construction of pools and riffles) was planned because it was not considered cost-effective, given the large investment in time and money that would be required. As a result, a principal research objective at Glen Creek was to determine whether and when the stream would naturally re-establish functional in-stream physical processes after the floodplain was rebuilt.

Restoration Schedule and Activities

All of the work done in Glen Creek proper was seasonal and accomplished during the summer months (June through August). Careful and detailed planning and design were accomplished during the rest of the year so that time available to work outside between spring thaw and fall freeze could be spent on actual restoration. Planning was begun in 1987 and actual restoration of Lower Glen Creek began in 1988 with debris removal and recontouring of tailings. Revegetation activities began in 1989 and continued through 1993 and may continue longer depending on the results. Floodplain and channel reshaping was a two-year effort conducted in 1991 and 1992. Brush bars were constructed of on-site alder. Jute matting and bio-logs (from coconut hull pieces) were ordered from a company and tried for one year, but were unsuccessful. Most of the initial research was completed by early 1994.

Results

For the next few years, the Glen Creek project will be monitored in the field to assess environmental outcomes, collect data to apply to other areas, and repair sites that may need additional work or maintenance. Pending funding, the NPS will continue to acquire claims and restore other sites in the Kantishna Hills Study Area.

Project Expenditures and Employment Creation

Project Finance

Most of the project was financed by the Alaska Regional Office of the NPS in Anchorage. Denali NPP contributed a significant amount of in-kind services, including labor and equipment. In addition, the NPS Water Resources Division, Wetland Program contributed $37,000 in 1992 for stream and floodplain work in Glen Creek. Arrangements between Denali NPP and the Alaska Regional Office varied from year to year. In some years, the project funds were transferred to Denali NPP and in other years, the project expenditures were made through the Regional Office.

Planning

Typical project planning and site-specific design costs for a stream restoration project are about 5 percent to 8 percent of project costs. Planning costs include: data collection, actual design, compliance with the National Environmental Policy Act; and cultural resources inventories (required by federal law). Development of a long-term reclamation plan for the entire Kantishna Hills Study Area cost an additional $20,000 in staff time for planning, field work and computer analysis of restoration effectiveness. Because Glen Creek was also a research project that was intended to evaluate the applicability of restoration techniques to other sites, planning and site-specific design costs were higher than they would have been with a non-research restoration project (Exhibit 15).

Site work, which included heavy equipment rental and operation for regrading tailings and reconfiguring the floodplain, revegetation, site clean-up and assorted other tasks consumed the major share (88 percent) of the project's budget. About 81 percent of the total budget was spent on labor, including equipment operators, and the rest on equipment rental (16 percent) and fuel and supplies (3 percent).

Site Work

The NPS also operated a field camp with support for the field crew (a camp manager and cook) and logistics (a helicopter manager and pilot). This camp supported other field efforts along with the Glen Creek project. Members of the four-person Glen Creek restoration team also served as site supervisors for many project aspects. Technicians from the NPS seasonal employee pool provided on-the-ground labor for one to two months, depending on the skills needed. For growing seedlings, the NPS contracted with the State Forestry Lab, which used prison labor, who were paid prison wages. The NPS also used Student Conservation Association volunteers (five people for five days in 1992), who were unpaid[9].

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[9] Labor costs for volunteers are not included in this case study analysis, because there are no indirect economic effects without wages to spend. Supervisory costs may have increased, but, if so, these were counted.

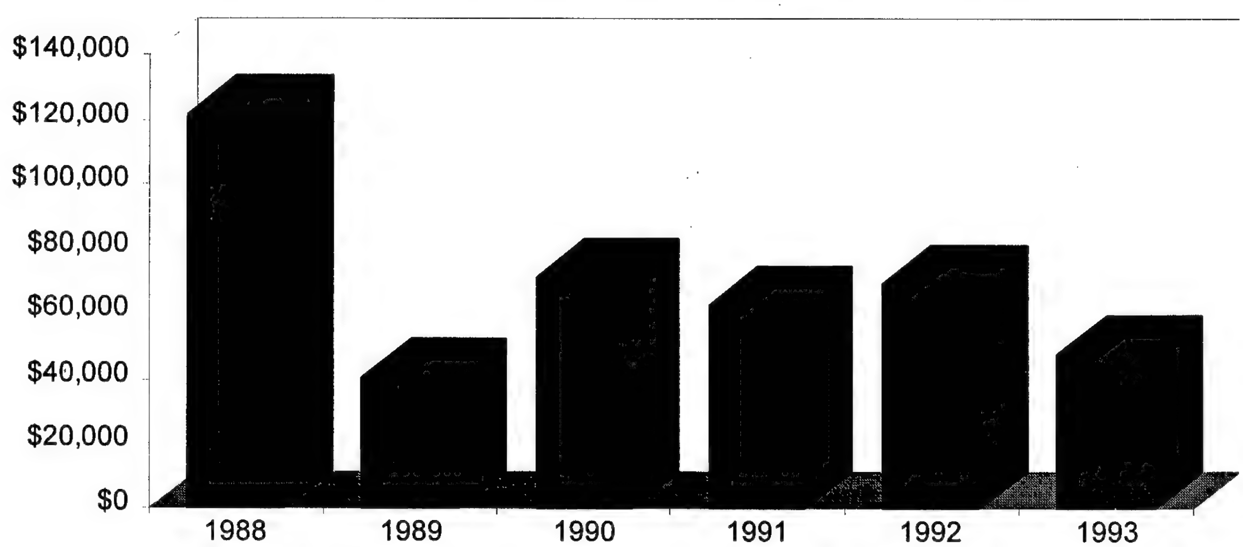
Exhibit 15. Glen Creek Project Categorical Expenditures (1991 dollars)

Activities	Cost	Percent of Project
Planning		
Planning, Research, Design	$34,000	8%
Site Work		
Stream Cleanup & Debris Removal	$45,000	11%
Streambank Stabilization	$14,000	3%
Revegetation	$191,000	46%
Regrading floodplain, reshaping	$50,000	12%
Equipment & Supplies		
Heavy Equipment Rental	$66,000	16%
Helicopters	$1,300	0%
Fuel	$6,000	1%
Miscellaneous supplies	$6,000	1%
Total	***$413,300***	***100%***

Equipment

The NPS used both its own and rented heavy construction equipment (bulldozers and bucket loader) and used its own operators. Heavy equipment operators were both full time and part time. The NPS hired the main operator, who also served as a mechanic, specifically for the Glen Creek project; other operators were existing NPS employees. The NPS determined that using its own employees provided more flexibility than hiring a contractor. Other necessary equipment was rented or owned by the NPS. Equipment use and rental differed by year depending on project requirements.

Exhibit 16. Glen Creek Project Annual Expenditures (1991 dollars)



Expenditure Patterns

As Exhibit 16 shows, a large proportion of the total project expenditures occurred in initial project stages (1988). Initial costs (1988) include a large sum for planning and research support (about two-thirds of the total planning costs shown in Exhibit 15), as well as significant heavy equipment and operator costs for on-site work. Off-season planning for the next season's site work continued throughout the life of the project. The tasks that were the focus of initial site efforts included regrading tailings piles and cleaning up and removing abandoned buildings, equipment and trash. The bulk of the revegetation work was accomplished in the second, third and fourth years of the project (1989-1991), while stream channel reshaping and floodplain stabilization took place in 1991 and 1992. Revegetation, monitoring and data collection were the principal on-site activities in 1993 at the Glen Creek site, although some clean up and removal of debris at other old placer mining sites in the Kantishna Hills also took place in 1993 (expenditures of $69,690 (1991 dollars)).

Employment Analysis

Additional categories of activities had to be added to the Alaska IMPLAN model to accommodate some differences between the Glen Creek project activities and the activity categories in the generic model constructed for this study (e.g. use of helicopters, regrading and reshaping of floodplains). Other Glen Creek activities (debris removal, revegetation) fit the mix of labor and capital investments in the template reasonably well, and other on-site work was assumed to be an average of all stream restoration efforts. Inevitably, some activities of any project will not match a generalized description of restoration activities, and appropriate modifications to the model used are essential.

Exhibit 17 shows how the Glen Creek Project's activities create employment in Alaska's economy (i.e., in-state jobs created per million dollars of expenditures) and Exhibit 3.4 estimates the actual number of job-years, or full time equivalents, created. As the direct jobs/million-dollars columns show, the labor-intensive activities -- planning, stream clean-up and debris removal, revegetation and other site work -- create the most employment per dollars of project cost (14, 22, 16 and 13 jobs/million-dollars, respectively). The indirect and induced jobs per million dollars of expenditures - those created by suppliers of goods and services to the project and as a result of respending wages, respectively - are low compared to the rest of the United States, due to Alaska's high level of dependence on imported products. Expenditures on labor-intensive activities have the largest employment creation effects in the Alaskan economy.

Exhibit 17. Alaska Stream Restoration Employment Creation (jobs/million dollars)

Restoration Activities	Direct jobs/$mm	Indirect jobs/$mm	Induced jobs/$mm	Total jobs/$mm
Planning	14.2	0.7	1.3	16.2
Stream Cleanup & Debris Removal	22.0	2.6	10.8	35.4
Regrading floodplain, reshaping	7.7	6.7	6.8	21.2
Revegetation	15.8	4.7	7.9	28.4
Heavy equipment and Helicopters	2.7	0.6	0.8	4.1
Other Site Work	12.9	3.3	6.6	22.8

The Lower Glen Creek Restoration Project created about 11 total jobs or job-years in the Alaskan economy over a six year period (i.e., about two jobs per year). Over ninety percent of the work was created by revegetation, bank and floodplain stabilization, and other site work -- and the industries that provided supplies to these activities, such as nurseries, heavy equipment suppliers, and trucking companies. Planning, research, debris removal and helicopters transportation provided the remainder of the job creation. These results are based on project expenditure records; there was actually some overlap among these categories because the researchers and planners were also on-site workers and supervisors; their activities are included as project work in some cases.

Exhibit 18. Estimated Employment Creation of Glen Creek Project

Restoration Activities	Costs (1991$)	Direct Job-Years	Indirect Job-Years	Induced Job-Years	Total Job-Years
Planning	$34,000	0.5	0.0	0.0	0.6
Stream Cleanup & Debris	$45,000	1.0	0.1	0.5	1.6
Regrading floodplain, reshaping	$122,000	0.9	0.8	0.8	2.6
Revegetation	$191,000	3.0	0.9	1.5	5.4
Other Site work	$20,000	0.3	0.1	0.1	0.5
Total	**$413,000**	**5.7**	**1.9**	**3.0**	**10.6**

Discussion

Although few people live in this remote area, and the unemployment level is high. The Borough of Denali has a permanent work force of 821, and an average unemployment rate of over 11 percent (1992 figures). Assuming a natural unemployment rate of 4 percent, this small project lowered the Borough's actual unemployment by about 4 percent. Finally, local economies in remote northern areas typically have significant non-cash components, such as hunting, fishing, and trapping. If stream restoration can increase fish populations in Glen Creek or downstream, it may improve the standard of living for some people, perhaps offsetting some of the effects of unemployment.

CHAPTER V. CONCLUSIONS

The three restoration case studies, as well as the evidence from federal programs, demonstrate the applicability of restoration to a variety of climate conditions and land forms, and represent a potentially effective way to create employment. Provided it achieves the environmental objectives it is designed for, restoration is clearly a strong option for consideration by policy-makers trying to evaluate the potential effectiveness of using stream restoration projects to create employment and even career opportunities among chronically underemployed segments of the population.

Each of the projects here is a laboratory for new procedures, with the consequential inefficiencies of trying something the first time. As more restoration projects are completed and the effectiveness and efficiency of practices improved, smaller portions of project costs can be expected to be devoted to planning and design and more to in- or near-stream work based on accumulated experience and results.

Depending on assumptions the employment creating efficiency of restoration can exceed that of capital-intensive structural water quality alternatives in virtually all cases. Some illustrative figures for structural alternatives to the case studies are compared with the nonstructural estimates (Exhibit 19).

Exhibit 19. Summary of Case Studies' Employment and Economic Effects

	Expenditure (1991$)	*Regional Economic Effects*	*Direct Job-yrs Created*	*Indirect Job-yrs Created*	*Induced Job-yrs Created*	*Total Job-yrs (Restor.)*	*Total Job-yrs (Struct.)*	*Net Diff.*
Anacostia River	$12,735,000	$43,000,000	208.0	48.0	198.0	454.0	170.0	284.0
Boulder Creek	$741,701	$21,000,000	13.2	2.7	10.8	26.6	13.5	13.1
Glen Creek	$413,300	$690,000	5.7	1.9	3.0	10.6	NA	NA

An immeasurable but considerable economic advantage of restoration projects and the firms involved with them is their entrepreneurial character and ability to quickly transfer technology and accumulated experience to new sites. In each case study, the publicly-initiated projects developed new techniques for stream restoration. Once other organizations and area governments learned of these projects and new approaches, they became anxious to apply the approaches to their local streams, creating additional work for stream restoration firms and the people they employ. In Colorado and Maryland, the desire to use native plant stocks for restoration has also spurred the development of native species nurseries, which are experiencing dramatic growth in demand for their products.

The success of federally-sponsored projects has generated demand for new restoration projects by local and state governments, as well as by private industry. Motivated entrepreneurs have established and expanded restoration and related businesses, creating both short- and long-term employment for potentially at-risk individuals. Restoration may be employment-effective, because it is characterized by both entrepreneurship, and labor-intensity. Further growth is contingent upon the ability of restoration practitioners and sponsors to disseminate information, particularly regarding the cost-effectiveness and success of restoration projects.

APPENDIX A: REGIONAL ANALYSIS MODELS

REGIONAL ANALYSIS MODELS

Input-Output Models

Input-output (I-O) models are the most common and widely used regional economic analysis tools. There are several versions available in the United States, all of which are based on data collected by the U.S. Department of Commerce, Bureau of Economic Analysis. While others are available, two of the most widely used models are RIMS, developed by the Department of Commerce, and IMPLAN, developed by the USDA Forest Service. Both of these are input-output models that are based on flows of funds surveys of all industries. They are founded on assumptions of fixed proportions, that is, once an industry's expenditure pattern has been identified (inputs from industries from which it makes purchases), any additional investment in that industry will result in increased expenditures on its inputs in exactly the same proportions as the original pattern. Regardless of how much demand for a product may increase as a result of a project or policy, I-O models implicitly assume that prices remain constant. In fact, no price information is included in the models, and it is assumed that no substitutions among factors of production to adjust to price changes occur.

These models also contain the implicit assumption that the relative contribution of the inputs -- labor, parts, machinery, buildings -- remains fixed over time. By contrast, recent productivity gains in the U.S. economy are the result of restructuring, that is, changing the relative proportions of inputs (e.g., reducing management costs) and eliminating some altogether, such as substituting microchips for transistors in computers. To develop accurate information on flows of expenditures, a large data gathering effort must be undertaken every few years to identify the purchases of governments, industries and households. Such data gathering efforts are extremely costly and therefore infrequent. Users of these models focus on inputs to specific industries or products of interest and assume that the production relationships and the local contributions (RPCs) of all other industries have stayed the same since the data were assembled.

IMPLAN and RIMS models identify flows of funds among more than 500 industrial sectors, allowing some specificity in identifying final demands (bills of goods) and resulting indirect and induced effects. Both are relatively low cost models to use. Of the two, the IMPLAN model was selected for use in this study primarily because IMPLAN has incorporated types of data and modifications not available in RIMS, and therefore provides a number of outputs in addition to value added and employment multipliers that are useful to this analysis, (for example, regional purchase coefficients and personal consumption expenditure multipliers may be adjusted).

Regional Econometric/Simulation Models

Regional econometric/simulation models have some features that input-output models do not. Unlike the I-O models, they incorporate price and elasticity data, which translates into shifts in demand (input price increases are passed through to final product prices, for which demand is then reduced), and purchases of substitutes increases. These models contain a significantly greater range of data types (e.g., wage rates and elasticities of demand or supply for modeled commodities) than I-O models. Therefore, they tend to use more aggregated industries to reduce data-gathering and analysis costs and to be calculable on small computers. The amount of information required is so great that sectors have to be grossly aggregated (to as few as 14 sectors to describe the entire U.S. economy).

For policies with broad-based and significant effects, such as increases in income or capital gains taxes, regional econometric modeling is a very useful tool. While the advantages of general equilibrium and simulation models may be important where specific cost increases need to be identified, they are of relatively little interest for analyzing the effects stream restoration investments. Furthermore, accuracy of results in the regional general equilibrium models depends on the validity of their embedded assumptions. For example, the source and accuracy of industry price trends varies considerably. General equilibrium models may be too blunt to be effective tools for non-structural analysis. However, with a detailed bills of goods for final demands, they may provide useful results.

The REMI (Regional Economic Models, Inc.) model is an integrated I-O and general equilibrium model with some important characteristics. It can provide regional wage rates, prices, population increases and profitability as a result of investments or policy changes. However, it is expensive, and has only 14 or 53 sectors, with the 53-sector model being very costly compared to the 14-sector model. Furthermore, the advantages it provides -- such as price and population changes -- are largely irrelevant to the discussion of the effects of NS/LC programs, since projects of the magnitude we are investigating would have no real effect on prices or population.

Export-Based Models

Export-based regional models are rare, largely because the data needed to develop them are not widely available. The export-based models operate on the premise that regional economic growth only occurs as a result of net exports (the value of exports minus the value of imports) of regional products. Without exports, funds are only being passed around among industrial sectors, with no net growth. This simplified interpretation is not entirely accurate, since productivity gains can be realized from intra-regional trade and specialization. Furthermore, investments by outside entities, such as federal government investment in regional products, creates employment, but may not generate net exports. (It is a net import of funds.) Unless the net export value of the commodities in which a project generates investment is known, employment effects can not be calculated, and this information is not readily available.

APPENDIX B. COMPENDIUM OF FEDERAL PROGRAMS WITH STREAM RESTORATION ACTIVITIES

PREFACE AND ACKNOWLEDGMENTS

This appendix was prepared by Apogee Research, Inc., for the U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation (OPPE), under Contract No. 68-W4-0022. Amy Doll, Senior Policy Analyst at Apogee Research, served as project manager. Christine Ruf, of the Water Policy Branch, Office of Policy Analysis, OPPE, served as Work Assignment Manager.

Much of the information in this report was gathered from telephone conversations and written materials provided by federal agency representatives. Apogee Research gratefully acknowledges the contributions of those government employees who provided information on individual stream restoration programs.

OPPE is conducting ongoing work on stream restoration activities among Federal agencies. This compendium was prepared to compile up-to-date information on Federal agencies engaged in programs that currently conduct, or are authorized to conduct, stream restoration. OPPE is distributing the compendium to encourage dialogue and cooperative efforts on stream restoration activities among Federal agencies as well as state and local agencies and nonprofit organizations involved in stream restoration.

For additional copies of this appendix or to provide comments on it, please contact:

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Washington, DC 20460
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DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
U.S. Department of Agriculture (USDA)					
Farm Service Agency (FSA), formerly Agricultural Stabilization and Conservation Service (ASCS)	Agricultural Conservation Program (ACP)	National	The ACP provides cost-share funds and technical assistance for a variety of conservation practices on private agricultural lands. ACP is designed to help prevent soil erosion and water pollution, protect and improve productive farm and ranch land, conserve water used in agriculture, preserve and develop wildlife habitat, and encourage energy conservation measures. Stream protection practices eligible under ACP include permanent fencing to protect streambanks from damage by domestic livestock; installation of livestock crossings that will retard sedimentation and pollution; and planting trees, shrubs, or perennial grass cover as filter strips or buffer zones along banks. In addition, streambank stabilization is included among ACP's special conservation practices, which are developed by counties to solve significant local conservation problems. Cost-share levels are set by county committees and are usually fixed for each practice. Variable levels of cost sharing are available in some counties that are based on the severity of erosion and the percent reduction in soil loss obtained by installation of the practice.	FY92 federal cost-share expenditures for stream protection: total -- $591,889 with primary purpose of erosion control -- $147,704 with primary purpose of water quality -- $439,196 FY92 federal cost-share expenditures for streambank stabilization: total -- $280,584 with primary purpose of erosion control -- $204,021 with primary purpose of water quality -- $76,563	Diane Sharp Agricultural Conservation Program USDA, FSA P.O. Box 2415 Washington, DC 20013 (202) 720-7333

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
FSA, formerly ASCS	Wetlands Reserve Program (WRP)	Nine states were selected for the 1992 pilot WRP, 20 states were eligible for the second WRP sign up in 1994	Under WRP, the USDA purchases easements and provides cost-share funds and technical assistance for restoration of wetland hydrology and vegetation. Participating landowners agree to pay 25 percent of the restoration costs and to perform maintenance of restored wetlands. Authorized by the 1990 Farm Bill, WRP focuses on restoration of farmed wetlands or wetlands converted to cropland. Acreage eligible for WRP include the restorable wetland area itself plus adjacent lands on which the wetland is dependent. Riparian areas along a stream or other waterway which connect wetlands that are protected by easement or other agreement are also eligible. Of the total accepted acreage under the 1992 pilot WRP (49,888 acres), around three percent (1,542 acres) are riparian areas or upland buffers adjacent to restored wetlands that will provide habitat complementary to the wetlands. During the second WRP sign up held in March 1994, almost 600,000 acres were offered for the program. Landowners that accept the appraised value are responsible for filing a permanent easement and for maintaining the wetland for the life of the easement. Landowners will receive compensation for cost-share assistance, reimbursement costs, and easement value.	FY92 appropriations for the 1992 pilot WRP were $46.357 million. No funds were appropriated for FY93. FY94 appropriations were $66.675 million to enroll not more than 75,000 acres in 20 states for the second WRP sign up. FY95 appropriations are $93.2 million. Under the Federal Crop Insurance Reform and Department of Agriculture Reorganization Act of 1994, administrative authority for WRP is being transferred from the FSA (formerly ASCS) to the Natural Resources Conservation Service (formerly the Soil Conservation Service) for the third sign up.	Lois Hubbard Conservation and Environmental Protection Division USDA, FSA P.O. Box 2415 Washington, DC 20013 (202) 720-9563

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
U.S. Forest Service (FS)	National Riparian Strategy	National Forests and Grasslands (191 million acres; 44 states and Puerto Rico)	The FS developed a national strategy for riparian management in 1991, calling for the restoration of riparian areas and wetlands throughout the National Forest System. In addition, all activities and uses will be designed so that healthy riparian areas and wetlands are not degraded by human activities. The FS goal is to complete restoration on 75 percent of the unsatisfactory riparian areas and wetlands by the year 2000. The extent and condition of riparian areas and wetlands within the National Forests will be inventoried by 1995. As a result of this strategy, important ecosystem values and functions are being restored where they had been degraded by past uses. Through the efficient use of existing funding, and seeking out partnerships among other agencies and National Forest users, progress toward the restoration of riparian areas and wetlands is being achieved.	Congress does not appropriate funds specifically for the Riparian Strategy. Funds have been earmarked from the national Watershed Improvement Program, as well as the Watershed Operations Program, to meet the goals of the strategy. In both FY94 and FY95, $3.65 million was budgeted for the Riparian Strategy. These funds have been combined with other appropriated funds (such as Fisheries Habitat Improvements or Range Improvements) in the field. Partnerships have also been developed with other federal, state, and local agencies as well as nonprofit organizations, to further the goals of the strategy.	Jim Golden Watershed and Air Management Staff USDA, Forest Service 14th and Independence SW P.O. Box 96090 Washington, DC 20090 (202) 205-0977

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
FS	Rise to the Future (RTTF) Fisheries Program	National Forests and National Grasslands	RTTF was developed by the FS in 1987 to encourage partnerships to improve the quality of fish habitat and enhance aquatic resources on national forests and grasslands. Through RTTF, the FS provides funds to National Forests to implement fish habitat management, which may include riparian and wetlands restoration projects. RTTF activities include developing a close working relationship with the Bureau of Land Management (BLM) in the implementation of the FS/BLM Recreational Fisheries Policy. RTTF also coordinates FS activities for the Bring Back the Natives initiative (see below), which involves stream restoration as part of an effort to reestablish native aquatic communities.	A FS fisheries program workforce analysis for FY93 found that 141.25 person years were devoted to habitat restoration and enhancement activities, which represents 17 percent of the total work force. Total funds approved under the President's budget for the FS fisheries management programs in FY94 and FY93 were: Anadromous fish habitat management -- \$28.867 million (FY94) \$26.979 million (FY93) Inland fish habitat management-- \$20.453 million (FY94) \$18.6 million (FY93) Aquatic threatened, endangered, and sensitive species management \$5.068 million (FY94) \$3.411 million (FY93)	Harv Forsgren Wildlife, Fish, and Rare Plants Staff USDA, Forest Service 14th and Independence SW P.O. Box 96090 Washington, DC 20090 (202) 205-0830

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
FS	Stewardship Incentive Program (SIP)/ Forest Stewardship Program (FSP)	Authorized in states with a State Stewardship Management Plan	Under SIP, the FS provides cost-share funds to private landowners to implement technical practices identified in approved Landowner Forest Stewardship Plans. The Forest Stewardship Program provides matching funds to state foresters to develop Landowner Forest Stewardship Plans. The FS has approved nine SIP practices for cost-share assistance, including riparian and wetland protection and improvement. State foresters determine SIP cost-share levels, practice priorities, and minimum acreage requirements.	The FY93 appropriation for SIP was \$17.8 million and the FY94 appropriation was \$17.9 million. The FY95 appropriation for SIP is \$18.3 million. The FY94 appropriation for FSP was \$15.7 million and the FY95 appropriation is \$16.0 million.	Mary Carol Koester Cooperative Forestry Staff USDA, Forest Service 201 14th Street SW Washington, DC 20250 (202) 205-1381
FS	Taking Wing Program	National Forests and National Grasslands	Taking Wing is the FS' waterfowl habitat management program. It provides funds for projects to protect, restore, maintain, and improve waterfowl habitat in national forests and grasslands. These projects are often implemented in cooperation with state and federal land management agencies and conservation organizations. Taking Wing is one program under the FS's umbrella wildlife program -- Get Wild! -- that includes protection and improvement of riparian and wetland habitats and conservation of the associated animals and plants.	Congress does not appropriate funds specifically for the Taking Wing Program. Expenditures for Taking Wing projects in FY93 were \$3 million and the budget for FY94 is \$2.9 million. Partners (e.g., nonprofit organizations such as Ducks Unlimited, state agencies, local groups, and other federal agencies) contribute additional funds, labor, equipment use, and/or materials to accomplish Taking Wing projects. In FY93, partner contributions totaled \$900,180.	Cynthia Ragland, National Coordinator Taking Wing Program One Waterfowl Way Memphis, TN 38120 (901) 758-3722 Ellen Campbell USDA, Forest Service P.O. Box 21628 Juneau, AK 99802-1628 (907) 586-7919

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS)	Rural Abandoned Mine Program (RAMP)	National	Under RAMP, the NRCS provides technical and financial assistance to landowners for conservation practices for the reclamation, conservation, and development of certain rural abandoned coal mine lands and water areas affected by abandoned coal mines. Assistance offered through RAMP can be used to reclaim these areas for approved uses, which includes wildlife habitat. The federal cost-share is 100 percent for projects where there is a threat to life or property and off-site damages, which is the category for all current projects. Other types of projects will be undertaken after this category is completed and the federal cost-share will be lower for those projects.	Funds for FY93 were $13.25 million and estimated funds for FY94 are also $13.25 million. Around two-thirds of total RAMP funding is for direct payments for conservation practices.	Bobby Rakestraw USDA, NRCS P.O. Box 2890 Washington, DC 20013 (202) 720-1866
NRCS	Soil and Water Conservation Program	National	This program provides planning and technical assistance for a wide range of soil and water conservation activities. Landowners and land users usually become cooperators with local Soil and Water Conservation Districts (which are local units of government organized by local residents under state law) to which the application for assistance is directed. This program also works in conjunction with other USDA programs, including ACP and WRP, to provide technical assistance for conservation and restoration practices.	NA	USDA, NRCS P.O. Box 2890 Washington, DC 20013 (202) 720-4527

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
U.S. Department of Commerce (USDC)					
National Oceanic and Atmospheric Administration (NOAA)	Coastal Zone Management (CZM) Program	36 states authorized to participate, including coastal states and territories, and Great Lakes states	Provides federal grant funding to states for development of CZM Programs (no match required) or implementation of CZM Programs (a minimum 50 percent non-federal match required). Currently, 29 states have federally approved CZM Programs. Use of funds provided through Section 306 implementation grants varies according to the emphasis of individual state programs, which may include stream restoration efforts in the coastal zone. Under Section 309 of the 1990 Coastal Zone Management Act amendments, states receiving CZM implementation grants may qualify for an enhancement grant to develop a multi-area strategy for their CZM program to address eight coastal issues of national significance: • Wetlands protection and restoration, • Special Area Management Plans, • Public access to the coast, • Control of the cumulative and secondary impacts of development, • Protection from coastal hazards, • Reduction of marine debris, • Management of ocean resources, and • Siting of energy and government facilities in coastal areas.	Section 306 implementation grants for FY93 totaled $35,472,000 and implementation grants for FY94 total $36,831,000 for all 29 states participating in the CZM program. In FY95, there will be an estimated $40,500,000 available for Section 306 implementation grants. Section 309 enhancement grants for FY93 totaled $4,226,800 and enhancement grants for FY94 total $6,258,856 for all 29 states participating in the CZM program. In FY95, there will be an estimated $6,700,000 available for Section 309 enhancement grants.	Debra Walker-Smith Coastal Programs Division Office of Ocean and Coastal Resource Management USDC, NOAA (SSMC4) 1305 East-West Highway Silver Spring, MD 20910 (301) 713-3102, ext. 146

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
NOAA and U.S. Environmental Protection Agency (EPA)	Coastal Zone Management Program: Coastal Nonpoint Pollution Control Program (CNPCP)	29 states and territories with approved CZM programs are required to develop CNPCPs	To comply with Section 6217 of the 1990 Coastal Zone Management Act amendments, each state with a federally approved CZM Program must develop a coastal nonpoint pollution control program, which must be submitted to both NOAA and EPA for approval by July 1995. These new state programs will focus on coastal watersheds for the purpose of implementing management measures for nonpoint source pollution to restore and protect coastal waters. A variety of management measures to protect and maintain sensitive areas along surface waters, such as streambanks and riparian zones, with the objective of protecting the water quality of the adjacent waterbody are among those specified in the CNPCP guidance. Another specified management measure promotes the restoration of preexisting riparian areas (and wetlands) where the restoration of such systems will have a significant nonpoint source pollutant abatement function.	In FY95, $5 million will be allocated to 29 states and territories.	Marcella Jansen Office of Ocean and Coastal Resource Management, Coastal Programs Division (N/ORM3), USDC, NOAA 1305 East-West Highway Silver Spring, MD 20910 (301) 713-3098, ext. 143 Stu Tuller U.S. Environmental Protection Agency Office of Wetlands, Oceans, and Watersheds Nonpoint Source Control Branch (4503F) 401 M Street SW Washington, DC 20460 (202) 260-7112

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRA-PHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
NOAA	National Marine Fisheries Service (NMFS) Restoration Center	National and International	The NMFS Restoration Center (RC) is the focal point for marine and estuarine habitat restoration within NOAA. The RC performs restoration through both litigation-related and non-litigation-related activities. Some of its coastal habitat restoration efforts involve application of hydrological restoration measures on river channels (e.g., the Atchafalaya River, Louisiana) to restore nearby wetlands. The RC participates in pursuing natural resource damage claims under several federal statutes that authorize NOAA to assess and claim damages for injuries to trust resources in marine and coastal settings as a result of discharges of oil or hazardous substances or other human-induced environmental disturbances. The RC uses recovered damages to restore, replace, or acquire the equivalent of injured resources. The RC also engages in a number of non-litigation-related activities. It plays a large role as part of a federal-state partnership mandated by the Coastal Planning, Protection, and Restoration Act to develop and implement habitat restoration projects for endangered wetland areas in Louisiana. Between 1991 and 1995, the RC was awarded ten restoration projects under this program. The RC also works with the U.S. Army Corps of Engineers to improve fisheries habitat at Corps Civil Works Project sites (see below).	NA	National Marine Fisheries Service Restoration Center USDC, NOAA 12th Floor, SSMC-3 1315 East-West Highway Silver Spring, MD 20910 (301) 713-0174

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
U.S. Department of Defense (DOD)					
United States Army Corps of Engineers (USACE)	Section 1135 Program	National, in association with existing USACE water resource projects	Authorized by Section 1135 of the Water Resources Development Act of 1986, as amended, the objective of this program is to improve the quality of the environment through modification of the structures and operations of water resource projects constructed by the USACE. The objective of a project modification is to restore or otherwise improve degraded fish and wildlife habitat. Restoration practices are implemented through sponsorship agreements with a 75 percent federal and 25 percent non-federal cost-share. Total costs for any 1135 project cannot exceed $5 million. Projects approved for implementation using this authority have included modifications of fish ladders, modifications to local flood protection projects which improve fisheries access to tributaries and also include beneficial plantings along the streambanks, reopening oxbows cutoff by flood control and navigation projects, modifications allowing increased water control in wetland areas, and creation of managed subimpoundments on Corps projects. Many of the approved projects contribute to the goals of the North American Waterfowl Management Plan and others contribute to the Coastal America program.	There is an annual appropriations limit of $25 million for the Section 1135 Program. The FY93 program appropriation was $7.5 million and the FY94 program appropriation was $8.13 million.	Ellen Cummings U.S. Army Corps of Engineers Headquarters (CECW-PM) 20 Massachusetts Ave NW, Room 7203 Washington, DC 20314 (202) 272-8532

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRA-PHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
USACE and NOAA	Marine Fish Habitat Restoration and Creation Program	Five NMFS coastal regions	The USACE and NOAA's NMFS, in conjunction with state fisheries and water resources agencies, conduct habitat restoration and creation projects with the goal of increasing fish and shellfish productivity and advancing habitat restoration technology in conjunction with the USACE Civil Works Program. The NMFS Restoration Center works with the USACE under a NOAA-USACE Memorandum of Agreement. Habitat restoration and creation opportunities may include marine, estuarine, and anadromous fish and shellfish habitats and are identified from within the overall USACE Civil Works Program. Restoration activities that could be selected under the program are removing stream obstructions or establishing riparian vegetation to restore anadromous fish runs. Although such activities are eligible under the program, none of the six ongoing projects includes stream restoration.	Program, while still authorized, is not currently receiving direct funding.	National Marine Fisheries Service Restoration Center USDC, NOAA 12th Floor, SSMC-3 1315 East-West Highway Silver Spring, MD 20910 (301) 713-0174

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
U.S. Department of the Interior (USDI)					
Bureau of Land Management (BLM)	Fish & Wildlife 2000	BLM administered public lands	Fish & Wildlife 2000 is a comprehensive strategic plan to improve management of fish, wildlife, and their habitats on BLM public lands between now and the year 2000. Eighteen National Strategy Plans, which are components of Fish & Wildlife 2000, guide the continued management of fish and wildlife resources and their habitats while ensuring multiple use. Under the auspices of Fish & Wildlife 2000, the BLM developed three national strategy plans for fisheries (Fisheries Habitat Management on Public Land, Anadromous Fish Habitat Management, and Special Status Fishes Management) to guide implementation of the FS/BLM Recreational Fisheries Policy. To execute these strategies, each state develops Fish & Wildlife 2000 and Recreation 2000 Plans to protect, restore, and enhance fish habitats to enhance recreational fishing opportunities. Many miles of stream habitats have been enhanced or restored, resulting in the improved production of recreational fish species, and the maintenance, and in some cases, progress toward the recovery of federally listed species. Under Fish & Wildlife 2000, BLM also coordinates its activities for the Bring Back the Natives initiative (see below).	Since the implementation of Fish & Wildlife 2000, the budget for BLM's Wildlife and Fisheries Program has dramatically increased from $15.4 million in FY86 to $47.5 million in FY94. The FY95 appropriation is $51.9 million.	Deborah New Wildlife, Fisheries, Rangeland and Forestry Sciences Group USDI, BLM 1849 C Street NW Washington, DC 20240 (202) 452-7753

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
BLM, FS, National Fish and Wildlife Foundation, and Trout Unlimited	Bring Back the Natives initiative	National Forests and National Grasslands, BLM administered public lands, and adjacent state and private lands	Bring Back the Natives began in FY92 as a new, national effort to restore the health of entire riverine systems and their native aquatic species. Individual projects focus on stream restoration to restore degraded habitat for the reestablishment of native species. The Bring Back the Natives initiative is coordinated through the BLM's Fish & Wildlife 2000 program and the FS' Rise to the Future Fisheries Program. Together, the BLM and FS manage more than 461 million acres (70 percent of all federal lands in the United States) and the aquatic habitats on these public lands include 283,000 miles of streams. In FY92, 20 projects were funded under the Bring Back the Natives initiative and another 20 projects were funded in FY93. Bring Back the Natives funded 19 projects in FY94. The National Fish and Wildlife Foundation is a private, nonprofit organization established by the U.S. Congress in 1984 to encourage and administer private contributions for the benefit of the nation's fish, wildlife, and plant resources. The Foundation awards challenge grants using its federally appropriated funds to match private sector funds. Challenge grants made by the Foundation during FY92 and FY93 were 50 percent federal grant funding and 50 percent non-federal contributions. Challenge grants in FY94 are 40 percent federal funds and 60 percent non-federal contributions.	Congress does not appropriate funds specifically for the Bring Back the Natives initiative; each cooperating federal agency uses funds from its fisheries program. Other funding is obtained by matching National Fish and Wildlife Foundation federal funds with non-federal partner contributions. In FY93, the FS and BLM received $800,000 to fund a total of 20 Bring Back the Natives projects. Other funds for FY93 were $188,475 contributed by the FS, $689,711 by the BLM, and $177,765 from other federal or state agencies. For FY94, the Bring Back the Natives initiative was awarded an $850,000 challenge grant by the Foundation for work on 19 projects.	Andy Martin BLM/FS IPA at National Fish and Wildlife Foundation 1120 Connecticut Ave NW, Suite 900 Washington, DC 20036 (202) 857-0166 Deborah Ann New Division of Wildlife and Fisheries USDI, BLM 1849 C Street NW Washington, DC 20240 (202) 452-7770 Mary Knapp Wildlife, Fish, and Rare Plants Staff USDA, Forest Service 14th and Independence SW P.O. Box 96090 Washington, DC 20090 (202) 205-1205 David A. Nolte Trout Unlimited 6322 NW Atkinson Avenue Redmond, OR 97756 (503) 923-3344

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
BLM	Riparian-Wetland Initiative for the 1990s	BLM administered public lands (and cooperative efforts with other public lands and private lands)	One goal of the BLM's Riparian-Wetland Initiative is to restore and maintain riparian-wetland areas so that 75 percent or more are in proper functioning condition by 1997. Riparian-wetland areas encompass 23.7 million acres of BLM lands, which represents 8.8 percent of the total land managed by BLM. Under this initiative, the BLM conducts riparian improvement projects and, as necessary, maintains those projects to continue their beneficial use. The BLM also acquires riparian-wetland areas through exchange, donation, or purchase. The initiative also encourages partnerships and cooperative restoration and management processes whereby non-federal partners participate in challenge cost-share agreements to contribute funds or services to implement specific wetland-riparian projects.	Funding for FY93 was $12.1 million. The FY94 appropriation is $18.8 million. An estimated 20 to 30 percent of funding is used for on-the-ground riparian restoration and riparian protection (e.g., fencing to restrict livestock access).	Don Waite Riparian-Wetland Initiative Division of Rangeland Resources USDI, BLM 1849 C Street NW Washington, DC 20240 (202) 452-7740

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRA-PHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
U.S. Fish and Wildlife Service (FWS)	Coastal Ecosystems Program (formerly Bay/Estuary Program)	11 funded programs in bays, estuaries, and coastal watersheds (11 more proposed programs)	The Coastal Ecosystems Program integrates FWS programs and activities (e.g., Partners for Wildlife, Fisheries, Federal Assistance, Refuges) and builds partnerships with other agencies and organizations within coastal watersheds. Through these partnerships, the program emphasizes elimination or reduction of threats to coastal living resources and focuses on on-the-ground actions to restore and protect native biodiversity (including fish, migratory birds, endangered species and their habitats). To date, the program has restored 21 acres of riparian habitat, reopened over 150 miles of streams for anadromous fish passage, restored over 925 acres of coastal wetlands, and planned or designed 5,400 acres of future habitat restoration. Additional activities include focused outreach to catalyze public action, and technical assistance to enable local decision makers to protect priority living resources.	Appropriations were $4.4 million in FY93 (9 programs) and $4.6 million in FY94 (9 programs). In FY95, appropriations are $5.5 million (11 programs).	Monty Knudsen or Steve Glomb Coastal Ecosystems Program Branch of Coastal and Wetland Resources U.S. Fish and Wildlife Service 4401 North Fairfax Drive, Room 412 Arlington, VA 22203 (703) 358-2201

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRA-PHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
FWS and National Fish and Wildlife Foundation	Fisheries Across America	National	The goal of Fisheries Across America is to restore and protect naturally functioning aquatic ecosystems to support healthy populations of native fish species. Criteria given high consideration in selecting proposed projects include projects that improve aquatic habitat, improve watershed and water quality, restore a depleted fishery resource, increase awareness of fishery and aquatic resource conservation, and involve a partnership between a non-federal entity and FWS. Any non-federal entity that can provide 50 percent of the cost of the project in cash or in-kind services is eligible to apply for a 50 percent grant of non-federal matching funds. Proposals are reviewed by the FWS Washington Office.	The National Fish and Wildlife Foundation has committed $300,000 in non-federal matching funds for FY95. This amount must be matched by $300,000 in cash or in-kind services by non-federal partners.	Doug Alcorn Fish and Wildlife Management Assistance U.S. Fish and Wildlife Service 4401 North Fairfax Drive, Mail Stop 820ARL Arlington, VA 22203 (703) 358-1718 Gris Batchelder National Fish and Wildlife Foundation 1120 Connecticut Ave NW, Suite 900 Washington, DC 20036 (202) 857-0166

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRAPHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
FWS	Partners for Wildlife	National; the focus is on areas that have historic migratory bird, endangered, threatened, or candidate species, or anadromous fish values, typically agricultural lands	Under the Private Lands/Partners for Wildlife initiative, private landowners are offered technical and financial assistance to restore wetlands or other declining habitats that have been drained or otherwise degraded. Restoration of upland riparian habitat may eligible if it will contribute to: the solution of problems on nearby refuges; the recovery of endangered, threatened, or candidate species, and certain migratory birds of management concern; the protection of adjacent wetlands; and the conservation or restoration of a globally or nationally imperiled natural community. The voluntary private lands restoration projects are administered under cooperative agreements with the FWS funding all or a portion of the costs. The FWS also funds habitat restoration on Farmers Home Administration (FmHA) easement and fee-title transfer lands. Habitat restoration activity in FY94 included: 54,739 acres of wetlands 189.5 miles of riparian restoration 9 miles of in-stream restoration 10,500 acres of native grasses Habitat restoration activity in FY93 included: 34,500 acres of wetlands 67 miles of riparian restoration 26 miles of in-stream restoration 10,000 acres of native grasses	The FY94 budget provided \$12.150 million for the Private Lands/Partners for Wildlife initiative, of which \$8.878 million was for habitat restoration and \$3.282 million was for technical assistance. The FY93 budget provided \$8.891 million for the Private Lands/Partners for Wildlife initiative, of which \$6.110 million was for habitat restoration and \$2.781 million was for technical assistance.	Charlie Rewa, Acting National Private Lands Coordinator U.S. Fish and Wildlife Service 4401 North Fairfax Drive, Room 400 Arlington, VA 22203 (703) 358-2161

Compendium of Federal Programs with Stream Restoration Activities (continued)

DEPARTMENT/ INDEPENDENT AGENCY	NAME OF PROGRAM/ INITIATIVE	GEOGRA-PHIC SCOPE	SUMMARY OF PROGRAM CHARACTERISTICS	BUDGET/ EXPENDITURES INFORMATION	CONTACT
National Park Service (NPS)	Rivers, Trails, and Conservation Assistance Program	National	The mission of the Rivers, Trails, and Conservation Assistance program is to help bring about significant changes and improvements in a community's recreation opportunities and open space. The NPS provides technical assistance to state and local governments as well as citizens groups to protect and restore river corridors. The program also assists in performing statewide river assessments, developing conservation strategies for individual streams or watersheds, pursuing National Wild and Scenic River designations, and in developing greenways.	The FY93 program budget was $6,965,000, the FY94 program budget was $6,853,000, and the FY95 program budget is $7,053,000.	Christopher Brown, Deputy Chief Recreation Resources Assistance Division USDI, National Park Service P.O. Box 37127 Washington, DC 20013 (202) 343-3780
U.S. Environmental Protection Agency (EPA)					
Office of Water; Office of Wetlands, Oceans, and Watersheds	Nonpoint Source Program Implementation Grants	National	Section 319 of the Clean Water Act sets forth requirements for the preparation by states and tribes of nonpoint source assessment reports and management programs to address waters where water quality standards are impaired or threatened by nonpoint source pollution. Under Section 319(h), EPA awards grants to implement approved management programs, including a range of projects that directly protect or restore specific surface waters, wetlands, or riparian areas. EPA's Section 319 grant guidance encourages states to develop and implement projects that incorporate a watershed approach to addressing nonpoint source problems.	Funding for Section 319(h) grants was $50 million in FY93 and $80 million in FY94.	Stu Tuller U.S. Environmental Protection Agency Office of Wetlands, Oceans, and Watersheds Nonpoint Source Control Branch (4503F) 401 M Street SW Washington, DC 20460 (202) 260-7112

LIST OF ABBREVIATIONS:

ASCS:	Agricultural Stabilization and Conservation Service (U.S. Department of Agriculture)
BLM:	Bureau of Land Management (U.S. Department of the Interior)
DOD:	U.S. Department of Defense
EPA:	U.S. Environmental Protection Agency
FmHA:	Farmers Home Administration (U.S. Department of Agriculture)
FSA:	Farm Service Agency (U.S. Department of Agriculture)
FWS:	Fish and Wildlife Service (U.S. Department of the Interior)
FS:	Forest Service (U.S. Department of Agriculture)
NMFS:	National Marine Fisheries Service (U.S. Department of Commerce)
NOAA:	National Oceanic and Atmospheric Administration (U.S. Department of Commerce)
NPS:	National Park Service (U.S. Department of the Interior)
NRCS:	Natural Resources Conservation Service (U.S. Department of Agriculture)
SCS:	Soil Conservation Service (U.S. Department of Agriculture)
USACE:	United States Army Corps of Engineers (U.S. Department of Defense)
USDA:	United States Department of Agriculture
USDC:	United States Department of Commerce
USDI:	United States Department of the Interior

APPENDIX C. GLOSSARY OF STREAM RESTORATION ACTIVITIES

**Glossary of Stream Restoration Activities
(used in IMPLAN models)**

Adding a Meander This is the process of rebuilding a meander into a stream that has been channelized. This process involves excavation of a new, curved stream bed. The purpose of adding a meander is to create habitat and return the stream channel to its natural course. In the typology, the costs associated with this restoration activity are solely the costs of trenching a new semi-circular, or arced, meander channel. Addition of meanders to a stream requires a channel block or other structure to divert flow into the new meander channel, as well as other practices such as revegetative flow diversion and bed replacement.

Bank Crib with Cover Log A bank crib with cover log is an instream device which is constructed by driving a row of abutment logs directly into a the side of a streambank, perpendicular to the bank and submerged. Then, another log is pinned on top of this row and parallel to the bank, to complete the base of the structure. Two more rows of abutment logs and two more cover logs, constructed exactly like the base, are placed on top of the base. The purpose of the bank crib and cover log is to protect unstable banks and provide overhead cover in the stream.

Barbed Wire Fencing This restoration activity involves placement of barbed wire fencing along both sides of a stream course to restrict human and livestock access, and allow undisturbed vegetative growth in the riparian zone.

Boulder Placement This practice consists of placing boulders within a stream channel. The purpose of boulder placement is to provide cover and pools, and reduce turbidity.

Brush Bundle This is an instream device which is constructed by wrapping vegetative debris and brush into a cylindrical bundle, and attaching the bundle lengthwise to a streambank. The purpose of a brush bundle is to provide habitat for stream fauna and to narrow and deepen small streams.

Chain Link Fencing This is the practice placing chain link fencing along both sides of a stream course to restrict human and livestock access, and allow undisturbed vegetative growth in the riparian zone.

Channel Block A channel block is an instream device which is constructed by pinning logs across an unwanted channel, and bolstering these logs with rock. The purpose of a channel block is to consolidate braided channels into a single, deeper channel.

Channel Constrictor A channel constrictor is an instream device which narrows a stream by forcing the water to flow between log/rock structures that protrude from both sides of the stream. To construct each side of the device, 2 logs are driven into the side of a streambank, roughly perpendicular to the bank and several yards apart. Then, a large log is pinned to the ends of the two logs protruding into the stream. The space between this large log and the bank is filled with other logs and rock. The purpose of the channel constrictor is to provide overhead cover, while increasing the depth and velocity of the water.

Debris Removal This is the process of manually clearing a stream of debris, which can severely obstruct flow or form a barrier to fish passage. Note: much of the natural large woody debris in a stream provides highly desirable habitat for fish and invertebrates, so debris removal must be executed with caution.

Grass Seeding Grass seeding is the process of planting grass in the riparian area, for the purpose of stabilizing streambanks and providing habitat. In order to complete the seeding process, the planting area must be graded, native grass seed must be spread, and mulch should be placed over newly planted areas.

Log and Bank Shelter A log and bank shelter is an instream device constructed by pinning a cover log to abutment logs that are driven perpendicularly into the stream bank at a meander. Given that the cover log spans the meander, the space between the log and the bank is filled with brush and other forest debris. The purpose of the log and bank shelter is to provide overhead cover, streambank protection, and habitat for insects and other fish food organisms.

Planting Shrubs This restoration activity involves planting naturally occurring shrubs and brush in the riparian zone. Planting requires manual clearing of the planting area, excavation of the subsoil, insertion of young shrubs or live cuttings, addition of top soil, and cleanup. The purpose of shrubby revegetation is to prevent soil movement and erosion, provide cover and shade, provide a source for detritus, and provide habitat for aquatic insects.

Planting Trees This practice consists of planting naturally occurring trees in the riparian zone. Planting requires manual clearing of the planting area, excavation of the subsoil, insertion of young trees, addition of topsoil, and cleanup. The purpose of woody revegetation is to provide a buffer along a stream that prevents erosion, create shade to keep water temperatures cool, and provide habitat.

Rip-rap Rip-rapping is the process of armoring of a streambank with broken rock. The pieces of rock are set into the side of a streambank to provide stability.

Rootwad A rootwad is an instream device which is constructed by driving the trunk of an excavated tree into the side of the streambank. The roots of the tree are left in the stream to provide cover and habitat.

Single-wing Deflector A single-wing deflector is an instream device which is constructed by pinning logs in a "V" pattern, with the open ends of the "V" driven into the side of a streambank. The interior of the "V" is filled with rock. The purpose of the deflector is to divert water flow so that meanders and pools are formed by scouring and relocation of fine sediment and gravel. A double-wing deflector is a combination of two single-wing deflectors.

Streambank Grading Grading is the process using earth-moving equipment to make the slope of streambanks less steep. The purpose of grading is to prevent erosion or to undo previous damage caused by disturbances such as mining. Streambank grading is often followed by revegetation.

Trash Catcher A trash catcher is a dam-like structure (whose body is made of hogwire, stretched across the stream), which filters debris and sediment from the course of a stream. In the process of collecting debris, the trash catcher fills, and acts like a K-dam or wedge dam to form scour pools.

Tree Cover Tree cover is an instream habitat creation technique, which is accomplished by felling a tree from a streambank into the channel of the stream. The tree remains attached to its stump like a hinge. The purpose of tree cover is to provide overhead cover and a substrate for aquatic organisms, increase stream velocity, and flush deeper scour pools.

Wedge, K, or Other Dam Wedge, K, and other small dams (also referred to as log drop structures, weirs, and check dams) are instream devices that span the width of a stream, using logs, rock and wire mesh as basic ingredients. The purpose of such a structure is to create pools by means of scouring action in shallow stream sections. In addition, the calm water above such a structure acts as a holding bin for organic materials.

APPENDIX D. BIBLIOGRAPHY

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This source focuses on the management aspects used by the Alberta Program to place fencing along streambanks. The article also provides information on the costs of fencing.

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This source summarizes riparian ecology and the functions of riparian vegetation in its ecosystem. In addition, the book broadly defines Best Management Practices for the riparian zone and presents several synopses of Northwestern riparian restoration projects.

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"Selecting and Managing Plant Materials..." describes the biological methodology involved in enhancing and constructing vegetative habitats. The article discusses seed biology, plant colonization processes, and other related topics.

11. Christopher J. Hunter, *Better Trout Habitat: A Guide to Stream Restoration and Management,* Washington, D.C.: Island Press, 1991.
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This paper describes and illustrates techniques used for three categories of stream restoration. These categories are bioengineering, streambank armoring, and aquatic habitat improvement.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
November 1994

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
Analyzing Employment Effects of Stream Restoration Investments

5. FUNDING NUMBERS

6. AUTHOR(S)
Apogee Research, Inc.
4350 East-West Highway
Bethesda, MD 20814

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers
Institute for Water Resources
Casey Bldg., Alexandria, VA 22315-3868 and
U.S. Environmental Protection Agency, Water Policy Branch, Office of Policy, Planning & Evaluation,401 M St.S.W. Washington, DC 20460

8. PERFORMING ORGANIZATION REPORT NUMBER
IWR Report - 94-FIS-18

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Environmental Protection Agency, Water Policy Branch, Office of Policy, Planning & Evaluation; and
U.S. Army Corps of Engineers, Headquarters
Directorate of Civil Works
Office of Interagency & International Activities

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Available from National Technical Information Service, 5258 Port Royal Road, Springfield, VA 22161 (703-487-4650)

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release; Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
This study reports on the potential employment effects of non-structural stream (riparian) restoration. Using a regional input-output model known as IMPLAN, detailed descriptions of stream restoration practices, and local and national information on stream restoration expenditures, this study estimates the regional employment creation effects associated with three restoration projects: Anacostia Creek in Maryland; Boulder Creek in Boulder, Colorado; and Glen Creek in Denali National Park and Preserve in Alaska.

14. SUBJECT TERMS
Regional economics, regional development, regional employment, input-output analysis, environmental and streambank restoration, riparian, public works

15. NUMBER OF PAGES
95

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited